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SPECIAL ENGINEER STUDY

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PREPARED FOR

ENGINEER INTELLIGENCE DIVISION
OFFICE CHIEF OF ENGINEERS
DEPARTMENT OF THE ARMY

BY

MILITARY HYDROLOGY BRANCH
WASHINGTON DISTRICT, CORPS OF ENGINEERS

54A-4074

ARTIFICIAL FLOODING POTENTIALITIES

AUSTRIAN ALPS

(INN, SALZACH, TRAUN & ENNS RIVERS)

SPECIAL ENGINEER STUDY
S-53-5

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NOVEMBER 1953

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ABSTRACT

This report analyzes the artificial flooding potentialities along the INN, SALZACH, TRAUN, and ENNS Rivers of the AUSTRIAN ALPS. It affords an over-all review of the relative artificial flooding possibilities of the area, as well as more detailed examination of results attainable at those locations and sites where conditions are most favorable for artificial flooding operations having significant military affects.

The most significant results would be attained by operation of the large gates of the "run-of-the-river" weirs, located in the lower reaches of the INN and ENNS Rivers to produce large and rapid streamflow variations in which stages would rapidly rise 1 to 10 meters and peak velocities range from 3 to 6 meters per second. While durations would be short, (from about 1 to 12 hours), repeated cyclic variations could be achieved by coordinated opening and closing of the gates of several weirs. Releases from the smaller outlets of other dams in the area would not produce sigificant streamflow variations along the major streams of the area.

Significant artificial flood waves could also be created by breaching of those hydroelectric power dams that impound large volumes of water. Although the storage capacities of most are rather small, breaching of dams at larger reservoirs, like the LIMBERG Dam in the SALZACH River basin or the SALZA Dam in the ENNS River basin, would cause rises in stages of 1 to 7 meters above normal, with velocities of 2 to 6 meters per second and flooded widths of as much as 1 kilometer in some places during the crest of the wave. The INN-SALZACH basin probably contains more such possibilities than other regions.

Long flood waves of several days duration could be created along the TRAUN River by breaching of several temporary dams at the outlets of the several large lakes of the region, when lake levels had previously been raised 1 to 2 meters above normal. Flooding of the flat flood plain along the lower reaches of the TRAUN to widths of 100 to 700 meters could thus be effected by the resulting 1 to 4 meters rise of stage. Peak velocities of as high as 3 meters per second could exist in places. Breaching of the many small mill weirs along this river would produce some local flood wave effects immediately downstream from the breached structures.

Possibilities for artificial flooding by means of stillwater barriers or drainage obstacles are not too favorable in this area due to the prevailing steep gradients. Erection of temporary dams at constricted sections, coupled with breaching of levees and disruption of drainage facilities, could create shallow inundation of low-lying reclaimed marshy areas. Such locations do exist in flatter sections

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that occur above gorges and in ancient glacial lake beds and basins along the middle reaches of the rivers, as well as along the lower reaches near the confluences with the DANUBE. Breaching of dikes and destruction of normal drainage facilities during natural or artificial flood periods could also create such flooding.

Artificial flooding measures would hinder installation and operation of floating bridges, and military ferrying and fording operations, when fixed bridges had been destroyed by demolition or bombing. Trafficability and maneuverability in inundated terrain adjacent to the streams could be impeded; but only slight disruption of traffic along major roads and railways along the sides of the valleys could be expected due to artificial flooding operations.

Continuous military support of the temporary or permanent dam installations would be necessary to prevent their destruction by enemy air or ground action. Destruction or failure of a dam would release a flood wave of short duration that would temporarily prevent or harass crossing operations and might cause failure of other downstream structures. Breaching of permanent dams or damage to the operating mechanism would prevent useful operation of the gates, especially for cyclic wave operation. Such destruction by enemy action would also prematurely release flood waves that could hinder movements of our forces below the dams. Deliberate demolition of those structures would prevent their use by the enemy during a later critical period.

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ARTIFICIAL FLOODING POTENTIALITIES
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ARTIFICIAL FLOODING POTENTIALITIES

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SECTION I

INTRODUCTION

1-01 ASSIGNMENT.

This study was assigned to the Military Hydrology Branch, Washington District, by letter from Office, Chief of Engineers, ENGWE, to the Division Engineer, North Atlantic Division: subject, "Military Hydrology R&D Project No. 8-72-12-001: Special Assignment" dated 9 January 1953.

1-02 PURPOSE AND SCOPE.

a. This report presents information regarding the hydraulic effects and nature of artificial flooding potentialities along the INN, SALZACH, TRAUN, and ENNS Rivers of the AUSTRIAN ALPS.

b. The study consists largely of a compilation and consolidation of information presented in various intelligence documents and technical publications, with certain supplementary analyses and discussions. The data and information forming the basis of this report were limited to that available in the Washington, D. C. area, or obtainable from other sources within the time allotted for the study. Detailed analyses were limited to factors considered to have the maximum military effect. A generalized qualitative evaluation was made of the less critical elements in order to determine their relative possibilities. A complete investigation of the entire area would require considerably more engineering data. Such an investigation probably would yield quantitative results which would furnish a more complete and detailed view of the artificial flooding potentialities of the rivers of the AUSTRIAN ALPS.

c. The report is designed to furnish basic data and results of analyses needed to answer questions concerning:

(1) Normal and extreme stages, discharges and velocities at key stations on the INN, SALZACH, TRAUN and ENNS Rivers.

(2) Stream characteristics including gradients, depths, and widths of channel and flood-plain on those streams.

(3) Data concerning locations and zero elevations of key gaging stations.

(4) Data concerning locations and dimensions of dams, lakes, and reservoirs.

(5) The extent of flooding possible by erection of temporary dams or disruption of drainage and irrigation facilities.

(6) The magnitude and duration of flood waves and flow variations created by breaching or regulated discharge from the dams, lakes, and reservoirs, and the effect on military bridging and crossing operations.

1-03 ARRANGEMENT.

This report is subdivided as follows:

Section I	Introduction
Section II	Drainage Basin Characteristics and Developments
Section III	Hydrologic Characteristics
Section IV	Artificial Flood Potentialities
Section V	Effect on Military Operations
Bibliography	
Tables	
Plates	
Exhibit A	Hydraulic Developments in the INN River Basin
Exhibit B	Hydraulic Developments in the SALZACH River Basin
Exhibit C	Hydraulic Developments in the TRAUN River Basin
Exhibit D	Hydraulic Developments in the ENNS River Basin

1-04 DEFINITIONS AND REFERENCE DATUM.

a. Equivalent English-Metric Terms. Most values used in this report are in the Metric System. Conversion factors for the English and Metric systems are presented for convenient reference in Table 1.

b. Abbreviations.

(1) The following abbreviations are used in this report:

cm	centimeters
h	hours
ha	hectares
hm^3	cubic hectometers ($10^6 m^3$)
km	kilometers
km^2	square kilometers
m	meters
m/sec	meters per second
m^3/sec	cubic meters per second

c. Hydrologic Terms. Special hydrologic abbreviations, in conformance with standard German and Austrian hydrologic practice, are defined in Table 2.

d. Elevation Datum. Elevations are in meters above the Adriatic Sea, "meters ueber Adria" (m.u.A.), the standard Austrian altitude datum unless otherwise indicated.

e. River Distances. In this report, distances are expressed in kilometers measured upstream from the river mouths, corresponding to that used in official Austrianhydrologic publications cited as References 1 and 2 in the Bibliography of this report.

f. Maps The drainage basins of the rivers of the AUSTRIAN ALPS are covered by the standard American AMS (Army Map Service) and British GSGS (Geographic Section General Staff) map series listed in Table 3.

g. Grid System. Grid references cited in this report are to the 1,000 meter "Universal Transverse Mercator" (UTM) Grid System unless otherwise designated.

1-05 REFERENCES.

All references cited in this report are listed in the Bibliography following Section V of the text.

SECTION II

DRAINAGE CHARACTERISTICS AND DEVELOPMENTS

2-01 GENERAL.

a. The INN River joins the DANUBE from the south at PASSAU, about 2225 km above the mouth of the DANUBE. The source of the INN is near the Swiss Alpine village of ST. MORITZ at an elevation of 2480 meters above sea level. The stream flows generally northeastward, entering AUSTRIA at MARTINSBRUCK. Of the total length of about 500 km, the upper 100 km lies in SWITZERLAND, the middle 200 km in AUSTRIA, and the lower 200 km in GERMANY. An area of approximately 26,000 km^2 is drained by this river. The SALZACH is the most important Austrian tributary, joining the INN near the border town of BRAUNAU, about 68 km above the mouth of the INN. Another important German tributary is the ALZ which joins the INN near the mouth of the SALZACH. Most of the other tributaries are short, steep mountain torrents. The important route to BRENNER PASS joining the northern or AUSTRIAN TYROL with the southern or ITALIAN TYROL follows the valley of the SILL (WIPPERTAL), tributary to the INN River at INNSBRUCK. Reference is made to Plate 1 for a general map of the area and to Plate 2a for a river basin map of the upper and middle reaches of the INN River.

b. The SALZACH River is tributary to the right bank of the INN River 68 km above the mouth of the latter. It rises in the KITZBÜHLER ALPS near GERLOS PASS and flows eastward for about 80 km to ST. JOHANN IM PONGAU, where it turns northward toward the INN. The lower 59 km forms the border between BAVARIA and AUSTRIA; the rest of the 226 km length lies entirely within AUSTRIA. An area of 6730 km^2 comprises the drainage basin of the SALZACH, a map of which appears on Plate 2b.

c. The TRAUN River basin of 4280 km^2 is surrounded by the INN, SALZACH, and ENNS River basins. The TRAUN is formed by the confluence of the ALTAUSEER TRAUN and GRUNDL TRAUN near BAD AUSEE. The river flows generally northward for about 150 km to join the DANUBE near LINZ. The region is characterized by a number of deep glacial lakes, notably the HALLSTAETTER SEE and TRAUN SEE on the TRAUN, the WOLFGANG SEE on the ISCHL tributary, and MOND SEE and ATTER SEE on the AGER tributary. A stream, known as the MUEHLBACH, closely parallels the left bank of the lower 25 km of the TRAUN, and is considered part of the TRAUN River complex. The relation of the TRAUN to the other river basins of the AUSTRIAN ALPS is shown by the general map, Plate 1. The stream network of the TRAUN River basin appears on Plate 2c.

d. The ENNS River rises near RADSTADT on the northern slope of the NIEDEREN TAUERN Alpine region. The stream flows eastward for 120 km to HIEFLAU, thence northward for approximately 130 km to join the DANUBE near MAUTHAUSEN, 180 km upstream from VIENNA. The ENNS valley provid

one of the major lines of movement across the difficult mountain country of central AUSTRIA. The valleys of the left side tributaries, with the exception of the STEYR, are much shorter than those of the right. The course of the ENNS River is shown on the general map, Plate 1 and on the river basin map, Plate 2d.

2-02 TOPOGRAPHY.

a. The General Terrain of this region is extremely rugged, consisting of high Alpine mountain ranges with deep glaciated valley troughs. The mountains are 2000 to 4000 meters above sea level. Several important passes (e.g., the RESCHEN SCHEIDECK, BRENNER and SCHOBER) provide communication across the Eastern and Central Alps. Movement in this region is mostly confined to the stream valleys, and transverse passage between river valleys is extremely difficult. Detailed descriptions of the topography of the region are contained in the documents listed as References 3 through 10 in the Bibliography of this report. Abstracts from those documents are included in Exhibits A through D of this report. Salient topographic features of individual river basins are outlined in following subparagraphs.

b. The INN River follows a relatively low-lying broad trough through the ALPS, falling steadily from 1027 m.u.A. at MARTINSBRUCK (Km 416) to 784 m.u.A. at LANDECK (Km 375) and to 480 m.u.A. at KUFSTEIN (Km 220). The lower portion in Germany and along the border consists of narrow gorges alternated with fairly wide valley sections. The streams tributary to the middle reaches of the INN have cut steep and narrow transverse gorges that fall abruptly into the deep valley of the INN with alluvial fans at their confluences. The SILL (WIPPERTAL) tributary (Km 295) is the most important transverse valley as it leads to the vital BRENNER PASS. The gradient of the INN River is illustrated on the river profiles, Plates 3a to 3c.

c. The SALZACH River valley is set deep in the heart of the Alpine region and is mainly of glacial origin. In its upper reaches the stream is almost torrential but the gradient flattens out near Km 210 and the trough widens to form a flat wide valley. Tributaries drop sharply into the main valley with extensive alluvial fans at the confluences (The KIMMLER ACHE (Km 212) has a sill 450 m high). Near BRUCK (Km 160) the valley progressively narrows to a deep gorge extending to ST. JOHANN (Km 127). Between there and WERFEN (Km 111), the valley widens to 400-500 m and emerges near GOLLING (Km 94) into a magnificent flat-floored trench, nearly 2 km in width. At SALZBURG (Km 66), the river enters the ALPINE FORELAND, where it crosses the basins of several ancient lakes. Before its course was regulated, it spread widely across an extensive flood plain with flat terrain on the German side of the river. The variation in gradient can be observed on the river profiles, Plates 3d and 3e.

d. The TRAUN River basin has been heavily glaciated with the consequent formation of trough-like valleys and extensive lake basins. The headwaters of the TRAUN are shallow torrential mountain streams that drain into the AUSSEE basin. The TRAUN continues through the gorge of the semicircular KOPPENTAL (valley), the fjord-like HALLSTAETTER SEE (lake), the densely populated GOISERN and BAD ISCHL basins (separated by the LAUFFENER bottleneck). From ISCHL (Km 103) to EBENSEE (Km 87) it passes through a narrow valley to enter the TRAUN SEE, a lake surrounded by wooded mountains. The river flows in a narrow, forested and untrafficable canyon from GMUNDEN (Km 72) to LAMBACH (Km 47), where it emerges onto a wide lowland where the riverbed is bordered by a wooded flood plain as far as its junction with the DANUBE. Reference is made to Plate 3f for general profile of the TRAUN.

e. The ENNS River valley above WENG (Km 135) is a broad flat-floored glaciated trough bounded by steep walls. Above SCHLADMING (Km 212), the valley is relatively narrow and irregular and has a steep gradient. From SCHLADMING to WENG, the gradient is flatter. In this reach the valley is an open trough filled with alluvial deposits with numerous swampy cutoffs and abandoned meanders. Below WENG the river enters a 17-km long narrow gorge known as the "GESAEUSE" which extends nearly to LAINBACH (Km 113). Downstream of that point, the ENNS gradient flattens and the stream passes through a number of narrow gorges alternated with wider terraced basins. At TERNBURG (Km 48) the valley widens and the river flows through symmetrical meanders incised 5 to 30 m below the neighboring terraces. Plate 3g indicates the gradient variations of the river.

2-03 GEOLOGY.

The geologic and structural formation of this mountainous region of AUSTRIA is complex and variable. The central crystalline core of the Alps is flanked on the north by a massive zone in which limestones predominate along with sandstone and shale. Farther north is a narrow broken fringe of grey shale interlaced with sandstones known to the Germans as "Flysch." The upper reaches of the INN and ENNS follow the west-east contact zone between the crystalline and limestone rock. Glacial action and subsequent erosion by wind and water have had considerable influence. The stream valleys are filled with alluvium and other sediments from lateral torrents and from old glaciers. Alluvial fans are prominent at the confluences of torrential tributaries. The rugged mountain ranges consist of rock, often bare but sometimes covered with a thin soil cover as indicated on the soils map, Plate 4. Detailed geologic information may be found in References 3 to 8.

2-04 DRAINAGE AREAS.

Drainage areas along the INN, SALZACH, TRAUN and ENNS Rivers are included on the graphs of Plates 3a to 3g. The drainage area of the

DANUBE above the mouth of the INN is approximately 50,500 km^2 and below the mouth of the ENNS about 90,600 km^2. Table 4 lists drainage areas at key gages. A tabulation of drainage areas of the rivers as listed in References 6 and 10 follows:

River	Drainage Area (km^2)
INN	26,131.0
SALZACH	6,733.7
TRAUN	4,240.4
ENNS	6,080.4

2-05 GRADIENTS AND PROFILES.

Stream gradients are generally steep, especially in the upper Alpine reaches. Some streams like the SALZACH and ENNS have relatively flat gradients in their middle reaches, but then drop sharply through gorge sections as may be seen on the river profiles of Plates 3a to 3g. A tabulation of average gradients on the major streams follows:

Reach	River Km	Average Gradient m/km
INN R.		
MARTINSBRUCK-MAGERBACH	416-343	5.1
MAGERBACH-SILL R.	343-295	1.9
SILL R.-REISACH	295-209	1.2
REISACH-MOUTH	209- 0	0.8
SALZACH R.		
SOURCE-WALD	225-210	96.0
WALD-BRUCK	210-162	2.4
BRUCK-GASTEINER ACHE	162-142	6.2
GASTEINER ACHE-GOLLING	142- 94	3.5
GOLLING-SALZBURG	94- 66	1.8
SALZBURG-MOUTH	66- 0	1.1
TRAUN R.		
ALT AUSEER SEE-HALLSTAETTER SEE	139-126	9.6
HALLSTAETTER SEE-TRAUN SEE	118- 85	2.6
TRAUN SEE-MOUTH	73- 0	2.4
ENNS R.		
PFEISSLINGBACH-AICH ASSACH	294-201	6.6
AICH ASSACH-WENG	201-135	1.2
WENG-GROSS REIFLING	135-107	6.2
GROSS REIFLING-MOUTH	107- 0	1.8

2-06 CHANNEL DEPTHS.

Except in the upper reaches, the major rivers are fairly deep, ranging generally from 1 to 3 m deep; however, the stream bottoms are

quite irregular and only at a few spots is fording feasible. Considerable erosion of the stream bottoms is continually taking place at some locations and silting of the bed at others. Depths are increased from 1 to 10 meters immediately upstream from the many hydroelectric power dams and small mill weirs, depending upon the height of the structure. At mean low water (MNW), depths are 0.2 to 0.5 m lower than at mean water (MW). Mean high water (MHW) stages range from 0.5 to 2.0 m above MW depth. References 2 to 9 contain information on river depths at specific locations. A tabulation of representative average depths follows:

Reach	River Km	Depth at MW (m)
INN R.		
MARTINSBRUCK-LANDECK	416-375	0.5-1.5
LANDECK-SALZACH R.	375- 68	1.5-3.5
SALZACH R.-MOUTH	68- 0	3.5-5.5
SALZACH R.		
SOURCE-BRUCK	225-162	0.5-2.0
BRUCK-GOLLING	162- 94	1.5-4.0
GOLLING-MOUTH	94- 0	1.0-3.5
TRAUN R.		
ALT AUSEER SEE-HALLSTAETTER SEE	139-126	1.0-3.0
HALLSTAETTER SEE-TRAUN SEE	118- 85	1.5-3.0
TRAUN SEE-MOUTH	73- 0	1.0-3.0
ENNS R.		
RADSTADT-WENG	231-135	0.5-1.5
WENG-GROSS RIEFLING	135-107	1.5-2.5
GROSS RIEFLING-MOUTH	107- 0	1.5-3.5

2-07 CHANNEL AND FLOOD PLAIN WIDTHS.

In general, streams are narrow in the mountainous headwaters and fairly wide in the lower reaches near the DANUBE. In many locations, the banks have been revetted and diked to minimize erosion and meandering. Construction of dams across the streams, especially in the lower INN River valley has resulted in appreciable increase of width in the pools above the dams. On most of the streams, narrow gorges alternate with wider basins or old glacial lake beds. Steep walls constrict the flood plains in the gorges to less than 500 m. Valley widths in the basins range from 0.5 to over 1.5 km, and are often marshy and poorly drained. However, in many cases the streams are incised deeply below the terraced valley floor so overbank flooding is unlikely. Where danger of flooding exists, levees restrict its extent. A tabulation of representative normal river widths is given below:

2-07

Reach	River Km	Channel Width (m)
INN R.		
MARTINSBRUCK-LANDECK	416-375	20- 60
LANDECK-REISACH	375-208	50-120
REISACH-MOUTH	208- 0	120-250*
SALZACH R.		
WALD-BRUCK	210-162	10- 30
BRUCK-GOLLING	162- 94	20- 70
GOLLING-MOUTH	94- 0	60-120
TRAUN R.		
ALT AUSEER SEE-HALLSTAETTER SEE	139-126	15- 40
HALLSTAETTER SEE-TRAUN SEE	118- 85	40-120
TRAUN SEE-MOUTH	73- 0	40-140
ENNS R.		
RADSTADT-WENG	231-135	10- 70
WENG-GROSS RIEFLING	135-107	50-100
GROSS RIEFLING-MOUTH	107- 0	30-300

* Pools above dams have widths up to nearly 1000 m in places.

2-08 NAVIGATION.

The INN, SALZACH, TRAUN and ENNS cannot be classed as navigable rivers. The steep gradients, variable depths, and swift currents of these Alpine streams minimize possibilities for navigation. However, during the Middle Ages and even up to the start of the present century, traffic by rafts, barges, and small craft did assume considerable economic importance in the region. Some downstream rafting of timber still occurs. In some localities, barges haul stone and construction material for river regulation works; but such movements are only for short distances within individual dam pools. The power dams built across the streams do not have navigation locks. On the TRAUN, many of the old small weirs have facilities for passage of rafts. Navigation by steamers, motor boats, and ferries is possible on the individual deep lakes in the TRAUN River basin.

2-09 REGULATION.

The many hydroelectric dams and reservoirs in the mountainous headwaters do not provide sufficient storage for significant regulation of flow for flood control, irrigation, or navigation. The lakes in the TRAUN River basin, however, considerably moderate flood flows. The "run-of-the-river" dams and weirs have sufficiently large outlet and gate capacities to pass even extreme flood flows. Considerable variation exists between low and high stream flows. Frequent dredging of the streams is necessary due to the large amounts of sediment and eroded material washed into the main rivers from the torrential tributaries. Channel rectification and bank revetments are common along extensive reaches of the river courses.

2-10 DAMS AND RESERVOIRS.

a. Hydroelectric Dams. Numerous hydroelectric projects are located on the streams of the AUSTRIAN ALPS. Most of those in the headwaters are located at the head of steep rapids and store only small volumes of water, relying upon high head for power generation. Along the lower, flatter reaches of the INN and ENNS Rivers are a number of "run-of-the-river" or "powerplant-in-stream" powerplants, which have large gated openings for passage of floodwater. These weirs range from 5 to 15 m high and can store from 1 to 60 hm^3. As indicated in Exhibit A and indicated on Plate 3c, a number of additional weirs are under construction or planned for the LOWER INN River. Additional weirs are also proposed for the ENNS River as described in Exhibit D. Locations of dams are shown on the general map, Plate 1. The locations of those on the main stems of the INN, SALZACH, TRAUN and ENNS Rivers also appear on the profiles of Plates 3a to 3g. Reference is made to Exhibits A to D for description of hydraulic features of important power developments as translated and abstracted from cited technical literature listed in the Bibliography. Table 5 provides a summary of data upon the more important hydroelectric dams, and includes references to sources in which additional information may be found. Sketches of typical dams used in this study appear on Plates 9a to 9e. The following tabulation lists pertinent data concerning the dams utilized in this study of artificial flooding potentialities:

Serial No.	Weir	River Km	Storage (hm^3)	Dam Height(m)	Flood Gates No.	Flood Gates Size(m)
INN R.						
R-8	KIRCHBICHEL	232	3.0(e)	6	4	20 x 6
					1	10 x 6
R-9	WASSERBURG	160	26.0(e)	10	4	17 x 9
R-10	TEUFELSBRUCK	147	8.2(e)	10	4	16 x 10
R-11	GARS	138	6.4(e)	9	4	17 x 9
R-12	JETTENBACH	128	4.2(e)	9	6	17 x 8.5
R-13	NEUOETTING	91	1.6(e)	9	5	18 x 8.5
R-14	BRAUNAU	61	29.0(e)	13.5	5	23 x 13.5
R-15	ERING	48	52.0(e)	12.0	6	18 x 12
R-16	EGGLFING	18	54.0(e)	14	5	23 x 13.5
SALZACH R. (KAPRUNER ACHE)						
R-27	LIMBERG	11	83.6	120	-	-
ENNS R. (SALZABACH)						
R-46	SALZA	6	10.5	53	-	-
ENNS R.						
R-47	GROSSRAMING	64	16.0	25	2*	22.5 x 5.5
					4	9 x 5.1
R-48	TERNBERG	48	5.1	17.5	3*	16 x 7
					3	16 x 7
R-51	STANING	20	10.0	13	5*	17 x 4
					5	17 x 2.8
R-52	MUEHLRADING	14	5.0	9	5	17.2 x 9

* Upper figure is top gate, lower is lower gate, separated by fixed middle portion.

(e) Estimated

b. Natural Reservoirs. The deep natural lakes described in paragraph 2-13a contain considerable water. Most of these lakes are concentrated in the TRAUN River basin. The TRAUN SEE volume of 2302 hm^3 is the largest. However, since the lake bottoms lie much deeper than the elevation of the outlets (about 190 m in the case of the TRAUN SEE), only a small part of the total volume is available for release.

c. Navigation Locks and Dams. There are no navigation locks or dams on the streams of the INN, SALZACH, TRAUN and ENNS basins. However, some of the small, older weirs have special openings for passage of rafts.

d. Mill Dams. Many small mill dams or weirs are located on the streams of the AUSTRIAN ALPS, especially in the upper reaches. They include millraces and supply canals and provide small amounts of water for local industrial use.

2-11 LEVEES.

Levee systems protect settlements and farming communities along the lower reaches and in those wide flat basins where inundation by floods are likely to occur. Bank revetments exist also in many places to stabilize the channels. Additional information may be found in References 6 to 10.

2-12 CANALS.

There are no navigation canals in this area. A number of short canals conduct water from the rivers to hydroelectric powerplants and mills. The MUEHLBACH that parallels the course of the lower TRAUN River has many small mill dams and might be considered as a canal. The 16 km long ALZ Canal permits diversion of water from the ALZ River to the SALZACH River for power purposes at the HULZFELD-BURGHAUSEN powerplant. Additional information concerning hydroelectric power canals is contained in Exhibits A, B, C and D of this report.

2-13 LAKES, GLACIERS, AND MARSHES.

a. Lakes. A number of deep lakes are located in glaciated valleys, mostly in the TRAUN basin. Since the lake bottoms generally lie much lower than the outlets, only the top layer of the lake surface is available for use in connection with hydroelectric supply. The lakes do appreciably reduce the peak discharges of floods and assist regulation of stream flows during other seasons. Area, volume, and depth of the more important lakes in the TRAUN basin, as given in Reference 12, are as follows:

Lake (See)	Area (km^2)	Volume (hm^3)	Maximum Depth (m)	Mean Depth (m)
GRUNDL S.	4.1	137.5	63.8	33.2
ALTAUSEER S.	2.1	72.4	49.0	34.6
HALISTAETTER S.	8.6	556.7	125.2	64.9
FUSCHL S.	2.7	99.5	61	37.4
WOLFGANG S.	13.2	619.2	109	47.1
TRAUN S.	25.7	2302.1	191	89.8
ZELLER S.	3.5	53.2	23	15.3
MOND S.	14.2	510.4	64	52.6
ATTER S.	46.8	3933.6	171	84.2

b. Glaciers. The topography of the AustrianAlps is largely a result of past glacial action. A few glaciers still exist at high altitudes in the HOHE TAUERN region just south of the INN and SALZACH Rivers. Melting of these glaciers is a major source of water supply for the mountain torrents that flow northward from the watershed of the Alpine core into the upper reaches of the INN and SALZACH Rivers. Neither the TRAUN nor ENNS basins contain active glaciers at the present time.

c. Ponds and Marshes. A number of wide flat valleys alternate with narrow gorges along the river courses. A notable example is the old glacial lake bed between HALLEIN (Km 80) and LAUFEN (Km 52) on the SALZACH River. These basins are often poorly drained and also contain remnants of abandoned river meanders which collect water. Consequently, they often are quite marshy, except where reclamation projects have been undertaken.

2-14 BRIDGES.

Detailed data covering present status of bridges across the SALZACH, TRAUN, and ENNS including bridge sketches, dimensions and other pertinent data are contained in USFA reports cited in the Bibliography as References 7, 8 and 13. Information on bridge locations and elevations also appear in the various volumes of Reference 6. Prewar bridge data may be found in Reference 14.

SECTION III

HYDROLOGIC CHARACTERISTICS

3-01 GENERAL.

a. Data concerning river stage, discharge, and flow duration are presented in generalized graphical form as far as practical in order to facilitate the application of the data to specific military problems. The references cited should be used for supplementary data.

b. Available hydrologic records are fairly complete except for the war periods of 1934 to 1947. Continuity of records have been affected in some cases by changes in locations of gages, by discontinuation of old and establishment of new gage sites, and by changes in gage zeros. Erosion and silting of stream channels, construction of dams and weirs, channel regulations, and other factors affect the applicability of past records under present-day conditions.

3-02 CLIMATOLOGY.

The climate at high altitudes in the AUSTRIAN ALPS can be classed as Middle European-Oceanian, while that in the valley lowlands has unmistakable Continental characteristics. The main features of the climate of the mountainous area are the heavy thunderstorms of summer and the alternation in winter between periods of bad weather, with snow and fog, and spells of good, but cloudy, weather. Precipitation fluctuates greatly from year to year. A good deal of the winter precipitation is in the form of snow. In the valleys the frost period extends from October through April; at high altitudes, it is longer. Above altitudes of 2000 m, temperature can, temporarily, drop below freezing, even in summer. Reference 15 contains some information on climate applicable in this area. Official Austrianrainfall records are published in References 1 and 16; additional climatologic data are contained in References 6 to 12. Seasonal variations in precipitation are illustrated graphically on Plate 5 of this report.

3-03 STREAM GAGING STATIONS.

Many stream gages have been established on the principle rivers of the AUSTRIAN ALPS. Stage records and other data for Austrian gages may be found in References 1, 2, 6, 12, and 16; for Swiss gages in Reference 17; and for German gages in References 18 and 19. Locations of gages are indicated on the river basin maps, Plates 2a to 2d and on the river profiles, Plates 3a to 3g. Pertinent gage data for key stations compiled from cited references are summarized in Table 4. Serial numbers of gages in AUSTRIA in Table 4 and on Plate 3 correspond to official Austrian serial numbers given in Reference 2. Swiss and German gages are designated on Plate 1 and Table 4 as Serial Numbers G-1 to G-5, inclusive.

3-04 RIVER STAGES.

a. Records. Mean and extreme stages of record, compiled for key stations from sources listed in paragraph 3-03, are tabulated in Table 4. The data cover various periods of record. Frequent changes of gage zeros recorded in various yearbooks necessitates that considerable care be exercised in comparison of recorded stages so that proper gage zeros are used. Changes in stream regime and construction of dams along the rivers should be considered in application of recorded data for existing conditions.

b. Stage Variation. Seasonal stage variations are illustrated on the graphs of monthly mean and extreme stages presented on Plates 6a to 6d. These were based on data in References 6 and 8. The river stages shown are characteristic of Alpine streams, with the maximum stages occurring in June or July as a result of heavier summer type rainfall as well as thawing of snow cover on the mountains during the late spring. The range between high and low stages during a given month is also much greater in the summer than in the winter months. Representative ranges between highest high water (HHW), mean water (MW), and lowest low water (NNW) are shown in the following tabulation:

Station	Serial No.	River Km	Gage Height (m) HHW	MW	NNW
INN R.					
INNSBRUCK	121	298	5.4	1.7	0.6
NEUOETTING	G-4	92	8.0	2.6	0.9
SALZACH R.					
NIEDERSILL	201	176	3.9	1.6	0.6
SALZBURG	251	66	8.1	2.0	0.4
TRAUN R.					
OBERTRAUN	3?2	131	2.6	1.5	0.7
WELS	399	31	10.6	2.8	1.6
ENNS R.					
LIEZEN	431	160	6.8	2.9	1.5
STEYR	466	32	6.0	1.6	0.4

c. Stage Duration. Stage duration curves for several key stations on the INN, SALZACH, TRAUN, and ENNS Rivers are shown on Plates 7a to 7d. These curves show the percent of time that a given stage may be expected to be equalled or exceeded. They were based on data contained in References 6 and 18. On these curves it may be seen that the median stage (equalled or exceeded 50 percent of the time) may differ slightly from the mean stage, MW (the arithmetical average).

3-05 RIVER DISCHARGES.

a. Records. Available official published records of river discharges are not as complete as for stages, although they are recorded in the same publications cited in paragraph 3-03. Discharges summarized in Table 4 are based on data contained in those references, supplemented by estimates derived by application of published stage data to the stage discharge relation curves described in the next subparagraph.

b. Stage-Discharge Relation. Average stage vs. discharge rating curves for key stations are presented in Plates 8a to 8d. These curves were estimated from old rating tables and recent equivalent stage and discharge statistical data contained in References 1, 6, 12, and 18.

c. Discharge Variations. Stream discharge follows the same seasonal pattern as that for stage discussed in paragraph 3-04b. Mean and extreme discharges are presented in Table 4 for stations where published data were available or could be estimated. The profiles of mean discharge (MQ) shown on Plates 3a to 3g illustrate the increase in discharge with increase in drainage area as one progresses downstream. The following tabulation illustrates the range between maximum, mean, and minimum discharges at representative key stations:

Station	Serial No.	River Km	Discharge (m^3/sec) HHQ	MQ	NNQ
INN R.					
INNSBRUCK	121	298	1250	160	15
NEUOETTING	0-4	92	3000	374	80
SALZACH R.					
NIEDERSILL	201	176	312	38	No data
SALZBURG	251	66	2250	172	26
TRAUN R.					
OBERTRAUN	332	131	170	20	3
WELS	399	31	1900	132	27
ENNS R.					
LIEZEN	431	160	750	64	20
STEYR	466	38	3200	177	40

d. Discharge Duration.

Discharge duration curves showing the percent of time that a given discharge is equalled or exceeded are not presented in this report, but may be found in References 6 and 18.

3-06 RIVER VELOCITIES.

a. General. River velocities vary according to the configuration of the river channel, depths, obstructions, restrictions, variations in slope, etc. Channel rectification, walls and levees, operation of dams and diversion structures, and other alterations to natural conditions materially affect the stream velocity. Tributary rivers during flood tend to raise the elevation of the water in the main channel; consequently, correlations between velocity and river stages are not applicable at all points along the adjacent river reaches, but serve merely as indications.

b. Surface Velocities. Insufficient basic data concerning channel characteristics (cross-sectional area, wetted perimeter, roughness, etc.), were available to accurately determine stage-velocity relation curves. As indicated in Reference 20, the maximum surface velocities likely to be encountered during crossing operations may exceed the mean surface*/ velocity by approximately 18 percent. The frequent drastic changes in gradient, alignment, and cross-section characteristics of the rivers of the AUSTRIAN ALPS makes for wide variations in velocity from point to point along the streams. Indication of velocities likely to be encountered may be deduced from the following tabulation of mean surface velocities at high (HW), mean (MW) and low (NW) conditions based on data contained in References 7, 8, 9 and 21:

River	Mean Surface Velocity (m/sec) HW	MW	NW
INN R.	3.5-5.0	2.5-3.0	1.0-1.5
SALZACH R.	2.5-5.5	1.5-3.0	No data
TRAUN R.	5 -6	0.5-1.5	No data
ENNS R.	1.5-4.0	1.0-2.0	0.5-1.C

c. Flood Wave Travel Time.

The rates of travel of flood peaks vary considerably. As pointed out in Reference 12, peaks of flood waves, occurring at times when stages are high, travel slower than do the peaks of small floods, occurring at times of low stages. Also, the location and development of the storm pattern influence the time at which contributing flow from the various tributaries reach certain locations. Estimated average rates of travel of flood peaks based on data in References 12, 22 and 23 follow:

*/ velocity by 25 to 75 percent; and the latter usually exceeds the mean cross-sectional

Reach	River Km	Average Travel Rate of Peak (km/hr)
INN R.		
LANDECK-INNSBRUCK	373-297	9.5
INNSBRUCK-BRAUNAU	297- 58	5.0
BRAUNAU-MOUTH	58- 0	6.0
SALZACH R.		
SALZBURG-NEUOBERNDORF	60- 48	3.0
NEUOBERNDORF-MOUTH	48- 0	7.0
TRAUN R.		
GMUNDEN-MOUTH	72- 0	6.5
ENNS R.		
AICH-STEYR	201- 31	6.0
STEYR-MOUTH	31- 0	4.0

SECTION IV
ARTIFICIAL FLOODING POTENTIALITIES

4-01 GENERAL.

a. The term "artificial flood," as used in this report, applies to any major increase in the extent of flooding, over that normally prevailing with existing developments, that is brought about by manipulation of control structures, breaching of dams or levees, or temporary damming operations designed to create flooding conditions. Applications of artificial flooding considered in this report fall into the following four general categories:

(1) Major flood waves, created by sudden breaching of a dam to release large quantities of impounded water.

(2) Streamflow variations, in which changes in discharges, depths, velocities, and widths of streams are brought about to hinder stream-crossing operations or navigation, such as might be accomplished by opening and closing outlet works of water-control structures.

(3) Stillwater barriers, created by flooding land to form water obstacles, using such means as breaching levees, diverting flow from canals, raising crests of existing dams, or constructing temporary dams.

(4) Drainage obstacles or mud-flats, in which the wetness of the soil is increased to impede military traffic, brought about by disrupting the normal drainage, destroying pumping and drainage facilities used to drain marshy or low land, by inducing shallow inundation of flood plains or reclaimed land, or by draining areas normally inundated by reservoirs.

b. Certain opportunities exist for effective use of these artificial floods on the INN, SALZACH, TRAUN, and ENNS Rivers. The most effective methods of flooding would be major flood waves or streamflow variations. This section presents a review of the potentialities and a quantitative evaluation of the hydraulic effects. Reference should be made to Section V for discussion of associated military factors.

4-02 MAJOR FLOOD WAVES.

a. General. This paragraph discusses the major artificial flood waves that could be produced on the SALZACH and LOWER INN Rivers by breaching of the LIMBERG Dam (R-27); on the TRAUN River by breaching of temporary dams at or near the weirs (SEEKLAUSEN) on the outlets of WOLFGANG SEE (R-41), HALLSTAETTER SEE (R-39), TRAUN SEE (R-43), MOND SEE (R-44), and ATTER SEE (R-45); and on the ENNS River by breaching of SALZA Dam (R-46). Since their available storage capacities rank among

the largest in their respective basins, the effects of breaching these structures would be more critical than from smaller reservoirs. A comprehensive study of artificial flood waves that could be produced from all the dams, singly or combined, within the region would involve considerable additional engineering data and more computation time than were available for this report. The artificial floods produced by opening the large gates of the "run-of-the-river" dams in the lower reaches of the INN and ENNS approach the magnitude and character of "major flood waves," but in accordance with the definitions of paragraph 4-01 are considered as "streamflow variations" and are discussed in paragraph 4-03. Reference is made to paragraph 2-10, and Exhibits A to D for descriptions of the dams studied, to Plate 1 for locations, to Plates 9a through 9e for sketches of the structures, and to Table 5 for summary of dam data.

b. Hydrologic Considerations.

(1) The initial river stages and flows, existing at the time of dam breaching, greatly influence the effects of the flood wave. Flow conditions in these Alpine streams vary considerably, both seasonally and annually, as discussed in Sections II and III and indicated on Plates 6a to 6d, and 7a to 7d. Operation of hydroelectric and other hydraulic developments also affects flow conditions. The initial streamflow, "base flow," at the start of the artificial flood waves assumed in this study, approximates normal mean water conditions.

(2) Reservoir stage and storage also influence the effectiveness of dam releases. Little information was available regarding the seasonal variation of specific reservoirs. However, pools probably could be expected to be full during the wet spring and early summer seasons and partly full during the drier autumn and winter periods. In this study, full pool conditions were assumed. Reservoir storage capacity curves shown on Plates 10a to 10d were estimated from data contained in the source references cited in Table 5 supplemented by topographic map information.

(3) Due to the prevailing high banks, narrow flood plains, and steep gradients of the streams and of the terrain, relatively small volumes of the flood waves could be expected to be retained behind embankments and in depressions on the flood plains, or lost by seepage. Consequently, no loss of volume of the flood waves was assumed in this study.

(4) Although a number of small low weirs are located on the streams downstream of the breached dams, their effect on the progress of the flood wave would be slight or primarily local, as the weirs are so low that they can pass high floods without significant adverse effect on stages. Various special conditions of operations were assumed for the large "run-of-the-river" dams in the lower INN and ENNS to reflect expected status under wartime tactical situations. These conditions are outlined in subsequent discussions for specific flood waves.

c. Means of Creating Major Flood Waves.

(1) LIMBERG and SALZA Dams. Breaching of the high dams, LIMBERG (R-27) and SALZA (R-46), would produce flood waves of appreciable initial peak magnitude but of short duration in the valleys of the SALZACH and ENNS Rivers, respectively. The type, shape and size of assumed breaches are hypothetical, but were selected to approximate the largest feasible effective breach openings believed likely to be produced in these dams by conventional bombs or placed demolition charges. In this connection, it should be noted that, as the wave travels downstream, the volume of released water and the hydraulic characteristics of the channel exert progressively greater influence upon the flood wave than does the shape and size of breach opening. It was assumed that the breach dimensions and discharge for these dams would be practically the same as that produced in the EDER Dam (a stonemasonry gravity structure in the WESER River basin of Germany) by the May 1943 bombing described in Reference 90. It was considered that similar openings could be produced in these concrete arch dams. Reference is made to Plates 9d and 9e for sketches of these dams. Discharge from the assumed breach would have an initial peak discharge of 8500 m^3/sec, but would rapidly decrease as the water stored in the reservoir rushed out through the breach, causing the pool stage to drop. The assumed breach approximates a parabolic shape with a top width of about 71 m and a depth of 25 m below the initial reservoir level, corresponding closely to the equation:

$$x^2 = 50 y$$

where x = horizontal distance from vertical axis of the opening

y = vertical distance above lowest point of the opening

(2) TRAUN River Lakes. Artificial flood waves produced by releases from these lakes were considered to be produced by two alternative methods. The first was by complete breaching or demolition of the small weirs regulating the outlet from the lakes or by similar destruction of temporary dams erected at more constricted bridge sections in the same vicinity. In this case, lake levels were assumed as being at the normal mean stage. The second method considered the lake level as being raised by temporary dams to the maximum stage considered feasible (2 m above normal for the ATTER, HALLSTAETTER, and TRAUN SEE and 1 m for the MOND and WOLFGANG SEE). Complete breaching or demolition of these structures would produce artificial flood waves. The estimated discharge curves are presented on Plate 10c. The estimated time required to raise the lake levels to the assumed above-normal stages at mean rates of inflow to the lakes are indicated in the following tabulation:

4-02c(2)

Lake	Stage above normal(m)	Volume Involved(hm^3)	Mean Inflow(m^3/sec)	Days to Raise Stage
WOLFGANG S.	1	13.2	5	31
HALLSTAETTER S.	2	17.2	35	6
TRAUN S.	2	51.4	75	8
MOND S.	1	14.2	10.5	11
ATTER S.	2	93.6	18	60

d. Effects of Major Flood Waves.

(1) General. The effects of artificial major flood waves are summarized in Table 6. Plates 11b to 11d show representative stage hydrographs and profiles of peak discharges for the flood waves produced on each stream by dam breaching. Due to the scarcity of accurate available data regarding channel and floodplain cross sections, flood-protection and stream-regulation levees and revetments, and other local features, broad assumptions as to extent of overbank flooding, stream depths and velocities had to be made. Discussion of the effects of specific major flood waves studied in the individual river basins follows.

(2) INN River Basin. No dams were considered as breached in this basin. Breaching of the LIMBERG Dam (R-27) in the SALZACH Basin would create a major flood wave, whose effects would be felt to some extent in the lower INN River valley below the junction of the SALZACH River (Km 68), as discussed in the next subparagraph. Reference is also made to the artificial flow variations produced by opening the large gates of the "run-of-the-river" weirs in the lower reaches of the INN, as discussed in paragraph 4-03. The volumes stored behind other dams in the basin are too small to create significant flood waves, except immediately downstream of the breached structures.

(3) SALZACH River-Artificial Flood No. S-1 represents the major flood wave on the SALZACH and INN Rivers created by breaching the LIMBERG Dam (R-27), located on the KAPRUNER ACHE, 11 km above its junction with the SALZACH at Km 166. A parabolic breach, approximately 70 m wide by 25 m deep, as described in paragraph 4-02c, was assumed. Reference is made to Table 6 for summary of effects and to Plate 11b for graphs of the resulting stage hydrograph. The initial 8500 m^3/sec peak discharge through the breach would decrease sharply to about 300 m^3/sec in 4 hours and then would drop more slowly as the reservoir level fell to the low point of the breach in about 24 hours. Approximately 30 hm^3 of the total 83.6 hm^3 storage capacity would be discharged through the breach opening, of which 10 hm^3 would be within the first 4 hours. As the wave traveled downstream, its peak would be considerably reduced. At BRUCK IM PINZGAU (No. 206), on the SALZACH 16 km below LIMBERG DAM, peak discharge would be 7400 m^3/sec above the base flow of 40 m^3/sec; at ACH (No. 281), 166 km below the dam, it would be 1480 m^3/sec above the 250 m^3/sec base flow at that point. This represents an increase of 6.2 m above the initial base flow conditions, at BRUCK and 3.8 m

at ACH. The wave would overtop the banks of the SALZACH but not of the INN below the SALZACH confluence. The width of flooding along the SALZACH would be 400 to 1000 m and peak velocities would be very high, about 3 to 6.5 m/sec. In this flood, it was assumed that the "run-of-the-river" weirs in the lower SALZACH and INN were opened and their pools empty. If those weirs were operated, the effects of this artificial flood wave along the INN could be considerably reduced. Representative critical values for Artificial Flood No. S-1 extracted from Table 6 are presented in the following tabulation:

PEAK VALUES - FLOOD NO. S-1

Station No.	Station Name	Stream Depth (m)	Overflow Height (m)	Width Flooded (m)	Mean Surf. Vel. (m/sec)	Duration above Bank (hrs.)
SALZACH R.						
206	BRUCK	8.0	2.0	1000	5.0	2
249	HALLEIN	8.5	0.5	400	4.5	2
281	ACH	6.5	1.5	800	4.0	6
INN R.						
G-5	WERNSTEIN	3.5	0	300	3.0	0

(4) TRAUN River-Artificial Flood No. T-1 involves the major flood wave on the TRAUN River created by breaching the existing GMUNDEN Weir (R-43), or a temporary dam erected at the constricted bridge opening immediately upstream, when the lake level of TRAUN SEE is at the normal elevation of 422.4 m.u.A. Reference is made to Table 6 for summary of effects and to Plate 11c for graphs of the resulting stage hydrographs. Approximately 25 hm^3 of water would be released from the lake as its level dropped from 422.4 to 421.5 m.u.A. The initial peak discharge of 240 m^3/sec would likewise decrease in about 110 hours to the mean water flow of 75 m^3/sec. Only slight reduction in peak flow would occur as this long wave traveled downstream. At the EBELSBERG gage No. 404), 67 km below TRAUN SEE, the peak discharge would be 290 m^3/sec, representing an increase of 150 m^3/sec above base flow as compared to 165 m^3/sec above base flow at GMUNDEN (No. 358), immediately below the lake. Depths in the river would be increased from 0.5 to 2.0 m above initial stages and would be confined within banks for most of the way. Velocities would be increased to about 2.5 m/sec in some places. Representative critical values extracted from Table 6 are presented in the following tabulation:

PEAK VALUES - FLOOD NO. T-1

Station No.	Station Name	Stream Depth (m)	Overflow Height (m)	Width Flooded (m)	Mean Surf. Vel. (m/sec)	Duration above Bank (hrs.)
359	ROITHAM	3.5	In Banks	100	1.5	0
391	LAMBACH	2.5	In Banks	60	2.0	0
404	EBELSBERG	3.0	In Banks	70	2.5	0

(5) TRAUN River-Artificial Flood No. T-2 represents the effect of raising the level of TRAUN SEE 2 m, prior to breaching a temporary special dam at the outlet. The volume and rates of discharge would be considerably higher than those of Flood No. T-1, where normal lake levels were assumed. Approximately 77 hm^3 would be released (compared to 25 hm^3 for Flood T-1) and the initial peak rate of outflow would be 710 m^3/sec (compared to 240 m^3/sec). It would take about 150 hours for the flow to recede to the 75 m^3/sec base flow at the lake outlet. The peak at EBELSBERG (No. 404) would be 715 m^3/sec, an increase of 575 m^3/sec above the 140 m^3/sec base flow at that point. Stages would be raised 2 to 3 m above initial stage and would be close to bankfull or slightly above banks for most of the course. The width of the water obstacle would be increased to about 100 to 400 m, and velocities would be raised to 2 to 3 m/sec. Reference is made to the artificial flood graphs on Plate 11c and the summary of data in Table 6. Extracts of critical representative values from the latter follow:

PEAK VALUES - FLOOD NO. T-2

Station No.	Station Name	Stream Depth (m)	Overflow Height (m)	Width Flooded (m)	Mean Surf. Vel. (m/sec)	Duration above Bank (hrs.)
359	ROITHAM	4.5	0.5	400	2.0	24
391	LAMBACH	4.5	Bankfull	100	2.5	0
404	EBELSBERG	4.5	0.5	350	3.0	12

(6) TRAUN River-Artificial Flood No. T-3.

(a) This flood probably approaches the maximum feasible artificial flood that could be produced on the TRAUN River. It involves coordinated breaching of special temporary dams at the outlets of the larger lakes of the basin when lake levels had been raised to the highest level deemed feasible. Lakes included are:

Lake	Lake Level Normal m.u.A.	Increased to m.u.A.	Raised (m)	Storage Released (hm^3)	Peak Discharge (m^3/sec)
WOLFGANG S.	539.2	537.2	1	25	85
HALLSTAETTER S.	510.4	508.4	2	21	450
TRAUN S.	422.4	424.4	2	77	710
MOND S.	481.6	480.6	1	28	95
ATTER S.	469.0	471.0	2	102	280

(b) In order to effect maximum combined peaks, breaching of the TRAUN SEE outlet should be delayed about 6 hours after the breaching of HALLSTAETTER SEE and WOLFGANG SEE outlets; breaching of the MOND SEE and ATTER SEE outlets should occur about 3 hours later than the TRAUN SEE breaching. Reference is made to the maps, Plate 1 or Plate 2c, for relative locations of the involved lakes. The effects of the combined flood

wave downstream from the junction of the AGER and TRAUN Rivers near LAMBACH (No. 391) would be appreciably greater than those produced by TRAUN SEE alone (Floods Nos. T-1 and T-2). As indicated on Plate 11c and in Table 6, the combined Flood Wave No. T-3, would have a discharge of 1005 m^3/sec at EBELSBERG (No. 404) compared to 290 and 715 for Floods Nos. T-1 and T-2, respectively. The combined flood wave would result in an increase of 2 to 4 m above initial stream levels. It would slightly overtop the banks along a considerable length of the river and would remain above banks for up to 2 days. This would increase the width of the water obstacle to as much as 700 m in the lower reaches of the TRAUN River. Mean surface velocities would be as much as 3 m/sec in places. The following tabulation lists critical effects at key locations:

PEAK VALUES. - FLOOD NO. T-3

Station No.	Station Name	Stream Depth (m)	Overflow Height (m)	Width Flooded (m)	Mean Surf. Vel. (m/sec)	Duration above Bank (hrs.)
359	ROITHAM	4.5	0.5	400	2.0	36
391	LAMBACH	5.5	0.5	150	3.0	18
404	EBELSBERG	5.0	1.0	700	3.0	54

(7) ENNS RIVER-Artificial Flood No. E-1 would be produced by breaching the SALZA Dam (R-46), located on the SALZABACH 6 km above its junction with the ENNS at Km 182. A 70 m wide by 25 m deep parabolic breach was assumed for this study, as described in paragraph 4-02c. A summary of effects appears on Table 6; stage hydrographs and peak discharge profile at key locations appear on Plate 11d. The initial peak discharge of 8500 m^3/sec would quickly drop as water flowed through the breach opening. The reservoir stage would drop to the elevation of the bottom of the breach in about 2.5 hours, releasing 10.4 hm^3, practically the entire reservoir storage volume. The crest of the flood wave would be reduced after passing through the wide flat valley of the ENNS above the GESAEUSE Gorge, the head of which starts near WENG (No. 439), Km 135. A considerable portion of the wave volume would temporarily go into overbank storage below the junction of the SALZABACH and ENNS, thus causing considerable reduction in peak flow. At WENG (No. 439), 53 km below SALZA Dam, the peak discharge would be only 700 m^3/sec above the 70 m^3/sec base flow at that location. Stages there would rise 3.5 m, nearly to top of banks, and velocities would be increased to about 3.0 m/sec. As the wave traveled downstream it would flatten, but not so sharply. At ENNS (No. 482), 4 km above the mouth, peak discharge would be 800 m^3/sec, an increase of 580 m^3/sec above the base flow of 220 m^3/sec. Stages downstream of WENG would be raised 1.0 to 2.5 above initial stages, but would be within banks. Velocities at the peak of the wave would range between 2.0 and 3.5 m/sec at various locations. In analysis of this wave, it was assumed that the "run-of-the-river" weirs in the lower ENNS were either previously opened or destroyed and their pools empty. If the pools were full, or the weir gates in suitable condition for closing, the effects of this wave below

Serial No.	Weir	River Km	Estimated Storage hm^3	Mean Inflow m^3/sec	Filling Time Hrs.
	INN River				
R-8	KIRCHBICHEL	232	3.0	300	3
R-9	WASSERBURG	160	26.0	300	24
R-10	TEUFELSBRUCK	147	8.2	350	6
R-11	GARS	138	6.4	350	5
R-12	JETTENBACH	128	4.2	350	3
R-13	NEUOETTING	91	1.6	370	1
R-14	BRAUNAU	61	29.0	700	12
R-15	ERING	48	52.0	700	21
R-16	OBERNBERG	35	54.0	700	22
	ENNS River				
R-47	GROSSRAMING	64	16.0	165	27
R-48	TERNBERG	48	5.1	170	8
R-51	STANING	20	10.0	220	13
R-52	MUEHLRADING	14	5.0	220	6

(3) Water stored behind upstream weirs can also be transferred downstream to refill pools whose storage has been depleted by previous releases. Cyclic streamflow variations downstream of a given weir can thus be facilitated. The average rate of travel of released water would be 7 to 9 km/hr on the INN and 5 to 7 km/hr on the ENNS. The following tabulation affords indications of the time elements involved in emptying any given pool by means of full opening of all gates and transferring the contents to the next downstream reservoir:

Serial No.	Weir	River Km	Estimated Storage hm^3	Emptying Time Hrs.	Travel Time Hrs.
	INN River				
R-8	KIRCHBICHEL	232	3.0	2	
					9
R-9	WASSERBURG	160	26.0	8	
					2
R-10	TEUFELSBRUCK	147	8.2	2	
					1
R-11	GARS	137	6.4	2	
					1
R-12	JETTENBACH	128	4.2	1	
					5
R-13	NEUOETTING	91	1.6	1	
					4
R-14	BRAUNAU	61	29.0	5	
					2
R-15	ERING	48	52.0	8	
					2
R-16	EGGLFING	35	54.0	6	

(TABLE CONTINUED ON FOLLOWING PAGE)

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Serial No.	Weir	River Km	Estimated Storage hm^3	Emptying Time Hrs.	Travel Time Hrs.
	ENNS River				
R-47	GROSSRAMING	64	16.0	4	
					2
R-48	TERNBERG	48	5.1	1	
					4
R-51	STANING	20	10.0	2	
					1
R-52	MUEHLRADING	14	5.0	2	

c. Means of Creating Streamflow Variations. Sudden opening or blasting of the large gates of the "run-of-the-river" weirs in the lower INN and ENNS Rivers would produce detrimental streamflow variations downstream from those structures. Partial gate openings or slower openings would produce lower but longer streamflow variations; although exact data on speed of gate openings were not available, it is estimated that gates could probably be fully opened in approximately one-half hour under emergency operating conditions. Plates 10a and 10d show estimated discharge rating curves for those gates, based on hydraulic data in Tables A-I and D-I and paragraphs A-09 and D-07 of Exhibits A and D. A tabulation of peak discharges under normal pool conditions follows:

Serial No.	Weir	Normal Pool (mNN)	All Gates Open No. Gates	All Gates Open Discharge m^3/sec
	INN River			
R-8	KIRCHBICHEL	496.5	4	1750
R-9	WASSERBURG	430.5	4	3400
R-10	TEUFELSBRUCK	420.5	4	3600
R-11	GARS	412.4	4	3400
R-12	JETTENBACH	403.0	6	3400
R-13	NEUOETTING	368.8	5	3700
R-14	BRAUNAU	348.5	5	7900
R-15	ERING	336.2	6	7200
R-16	EGGLFING	325.9	5	8400
	ENNS River			
R-41	GROSSRAMING	371.0	6	3500
R-48	TERNBERG	330.0	3*	3700
R-51	STANING	282.0	5*	3350
R-52	MUEHLRADING	268.0	5	3500

* Upper & Lower movable gates, separated by fixed middle part.

d. Effects of Streamflow Variations.

(1) General.

(a) The effects of streamflow variations produced by releases from the gated outlets of the weirs on the INN and ENNS Rivers are summarized in Table 6. Plates 11a and 11d show representative stage hydrographs and profiles of peak discharges for the flow variations considered.

(b) Reference is also made to paragraph A-05 of Exhibit A for discussion of estimated effects of similar operations of the INN River weirs as studied in 1937 by the "Mil-Geo" organization of the German Army. Those estimated results are generally compatible with effects computed in the current study covered by this report, although assumptions as to base flow and operation schedule differed somewhat from those assumed in the current study.

(c) The flow variations studied are designated for purposes of identification as follows:

Flood No.	Dams Involved No.	Name	Gate Operations
INN River			
I-1	R-8	KIRCHBICHEL	All gates opened at Hr. 0
	R-9 to R-13	Group A*	All gates opened at Hr. 3.5
	R-14 to R-16	Group B*	Weirs open and pools empty
I-2	R-8	KIRCHBICHEL	All gates opened at Hr. 0
	R-9 to R-13	Group A*	All gates opened at Hr. 3.5
	R-14 to R-16	Group B*	All gates opened at Hr. 9
I-3	R-27	LIMBERG	Breached 2 hrs. before R-8 (See Flood S-1, par. 4-02d)
	R-8 to R-16	Same as Flood No. I-1	
I-4	R-27	LIMBERG	Breached 2 hrs. before R-8 (See Flood S-1, par. 4-02d)
	R-8 to R-16	Same as Flood No. I-2	
ENNS River			
E-2	R-51	STANING	All gates opened at Hr. 0
E-3	R-47	GROSSRAMING	All gates opened at Hr. 0
E-4	R-47	GROSSRAMING	All gates opened at Hr. 0
	R-48	TERNBERG	All gates opened at Hr. 0.5
	R-51	STANING	All gates opened at Hr. 1.5
	R-52	MUEHLRADING	All gates opened at Hr. 1.5

* Group A: WASSERBURG (R-9), TEUFELSBRUCK (R-10), GARS (R-11), JETTENBACH (R-12), NEUOETTING (R-13)
Group B: BRAUNAU (R-14), ERING (R-15), EGGLFING (R-16)

(2) INN River-Artificial Flood No. I-1 involves sudden full opening of the gates of KIRCHBICHEL Weir (R-8) at Km 232, followed 3.5 hours later by sudden full opening of the gates of the 5 INN River weirs (Group A), designated as R-9 to R-13 in Tables 5 and 6 and located between Km 160 and Km 91. Prior to gate opening, the pools were assumed as being full. In this flood, gates of the three Group B weirs, R-14 to R-16, located farther downstream on the INN River between Km 61 and Km 35 were considered as being previously opened or destroyed and their pools as being empty. Release of the 5 hm^3 of water contained in the JETTENBACH-TOEGING canal leading to the TOEGING powerplant was not considered in this study. Addition of that volume by opening the waste gates at the powerplant could release a peak flow of about 350 m^3/sec. The canal would be emptied in approximately 4 hours. This would slightly increase the magnitude and duration of the artificial flood. The effects of the flood studied are summarized in Table 6. The peak discharge profile and representative stage hydrographs at several critical locations are shown on the flood graphs of Plate 11a. This coordinated operation would result in a flow variation with peak discharge approaching the maximum capacity of the respective weirs, 1825 m^3/sec for KIRCHBICHEL (R-8) and 3500 to 3750 m^3/sec for the other Group A weirs. Separate operation of individual weirs would result in approximately the same discharge, immediately downstream from the weir operated, as for combined operation of all the weirs involved in this artificial flood. However, the peaks would be more sharply reduced as the flood progressed downstream and its duration considerably shortened. The crest of Artificial Flood No. I-1 would result in an increase over initial stages of 1 to 6 m in the open river sections not included within the backwater pools of the weirs. However, the pool stages would not be raised appreciably during the passage of the crest and, of course, would be greatly lowered as the pools were emptied. The crest stages would be within banks for most of its course. Velocities during the passage of the crest would be increased to about 3 to 5 m/sec in some places. Representative critical values extracted from Table 6 are presented in the following tabulation:

Station No.	Station Name	Peak Values - Flood No. I-1: Stream Depth (m)	Overflow Height (m)	Width Flooded (m)	Mean Surf. Vel. m/sec	Duration above Bank (hrs.)
G-2	ROSENHEIM	2.0	In Banks	300	2.5	0
G-3	WASSERBURG FERRY	6.0	0.5	450	4.5	2
282	BRAUNAU GAGE	5.5	In Banks	280	5.0	0
G-5	WERNSTEIN	4.0	In Banks	400	3.5	0

(3) INN River-Artificial Flood No. I-2 results from similar gate openings as Flood No. I-1, except that the INN River Group B weirs were considered as also being in operation with initial full pools. The gates of the Group B weirs, R-14 to R-16, were considered as being opened 9 hours after the initial gate opening operation at the farthest upstream

weir, KIRCHBICHEL (R-8). Above the BRAUNAU Weir (R-14), effects would be identical to Flood No. I-1. Downstream from that weir, the crest would be considerably higher and its duration longer, as may be seen from the summary of effects of Table 6 and the graphs of Plate 11a. The large discharge capacity of the Group B weirs, 7300 to 8700 m^3/sec, would create a flow variation of considerable magnitude. Stages downstream from BRAUNAU would be raised to nearly 10 m above initial base flow stages in open river reaches, but pool stages immediately upstream from the weirs would not be appreciably increased during the passage of the wave. As in the case of the previous artificial flood, No. I-1, separate operation of individual weirs could be expected to result in shorter flow variations of practically identical peak discharges immediately below the weir operated. Farther downstream effects would be much less than with combined operation of several weirs. Downstream from BRAUNAU, the crest of Flood No. I-2 would be near top of banks or dikes. In some places banks would be overtopped. For example, flooding to 3.5 m over the bank would occur near WERNSTEIN. The width of the water obstacles in flooded overbank areas would reach about 1 km in places. Peak velocities would be extremely high, reaching to about 6.5 m/sec in some locations. The following tabulation presents critical values at key locations as abstracted from Table 6:

Station No.	Station Name	Peak Values – Flood No. I-2: Stream Depth (m)	Overflow Height (m)	Width Flooded (m)	Mean Surf. Vel. m/sec	Duration above Bank (Hrs.)
	Above BRAUNAU		Same as Flood No. I-1			
282	BRAUNAU Gage	9.0	1.5	1000	3.5	1
R-16	EGGLFING Tailwater	11.5	Bankfull	500	6.5	0
G-5	WERNSTEIN	9.0	3.5	400	5.0	10

(4) <u>INN River-Artificial Flood No. I-3</u> represents the combination of discharge from KIRCHBICHEL (R-8) and the Group A INN River weirs used in Flood No. I-1, plus the flood wave resulting from breaching of LIMBERG Dam (R-27) on KAPRUNER ACHE, a tributary of the SALZACH. The latter corresponds to Artificial Flood No. S-1, described in paragraph 4-02d(3). By breaching LIMBERG Dam 2 hours before opening the gates of KIRCHBICHEL and 5.5 hours before gate openings of the Group A weirs, the peaks would approximately coincide at the junction of the SALZACH and INN Rivers, Km 68. This would result in slightly increased effects downstream of that junction, over those resulting from the separate Floods I-1 or S-1. Comparative effects can be seen on Table 6 and on Plate 11a. At WERNSTEIN, the peak discharge of Flood No. I-3 would be 2980 m^3/sec, compared to 2010 m^3/sec for Flood No. I-1, and 1760 m^3/sec for Flood No. S-1. However, this increase would be sufficient to effect overtopping of banks at some critical places where the crest of Flood No. I-1 would be slightly below bankfull. Likewise, velocities and other factors would be similar in Floods I-1 and S-1. Critical values on the INN River at WERNSTEIN (G-5) abstracted from Table 6 for Artificial Floods Nos. S-1, I-1 and I-3 are shown in the following tabulation for comparison:

Peak Values at WERNSTEIN (G-5)
Floods Nos. S-1, I-1, & I-3

Flood No.	Stream Depth (m)	Overflow Height (m)	Width Flooded (m)	Mean Surf. Vel. m/sec	Duration above Banks (Hrs.)
S-1	3.5	In Banks	300	3.0	0
I-1	4.0	In Banks	400	3.5	0
I-3	5.0	0.5	400	4.0	4

(4) INN River-Artificial Flood No. I-4 shows the effect of coordinating breach discharge from LIMBERG Dam (Flood No. S-1) with the gate releases of all eight existing INN River weirs, as represented by Flood No. I-2. The resulting increase in effects downstream from the SALZACH-INN junction would not be appreciably greater than for Flood No. I-2. The additional volume from LIMBERG Dam would slightly increase durations on the recession side of the hydrograph. Reference is made to the summary of effects in Table 6 and to the flood graphs on Plate 11a. The following tabulation shows that effects at WERNSTEIN are identical for Flood Nos. I-2 and I-3:

Peak Values at WERNSTEIN (G-5)
Floods Nos. I-2 & I-3

Flood No.	Stream Depth (m)	Overflow Height (m)	Width Flooded (m)	Mean Surface Vel. m/sec	Duration above Bank (Hrs.)
I-2 & I-3	9.0	3.5	400	5.0	10

(5) SALZACH River Basin. Opening or breaching the outlets of the hydroelectric dams in the SALZACH Basin would not produce large streamflow variations, as the discharge capacities are less than stream channel capacities. Some increase in velocities and stage might be expected for short distances downstream from the outlet releases, but would probably not be critical in most cases. Combined operation of outlets of a number of dams might produce worthwhile results, but the necessary coordination would be very complex and was not analyzed in this study.

(6) TRAUN River Basin. Water released by operation of the regulated outlets of the many small weirs along the streams of the TRAUN River basin would produce some variations of stages and discharges a short distance downstream of the structure operated. However, the stage would be raised less than 1 m. Velocities would not exceed 3 m/sec, and very little overbank flooding might be expected. Except for the weirs at the lake outlets, the volume of water impounded by the weirs is small. Consequently, duration of streamflow variations would be short, unless a number of weirs were progressively opened. Opening of the weirs would cause the stream depths upstream from the weirs to be lowered by emptying of the pools. Reference is made to paragraph 4-02 for discussion of the effects of major flood waves produced on the TRAUN River by means of breaching dams located at the outlets of the various lakes in the TRAUN River basin.

(7) ENNS River - Artificial Flood No. E-2 involves sudden full opening of the gates of STANING Weir (R-51) at full pool conditions. It was assumed in this flood that the MUEHLRADING Weir (R-52), 6 km downstream had previously been opened or destroyed and its pool empty. Effects of this flood are summarized in Table 6. Peak discharge profile and stage hydrographs are shown on Plate 11d. This flood wave would have an initial peak discharge of 3550 m^3/sec at STANING Weir, and the total 10.0 hm^3 stored in the pool would be discharged in approximately 2 hours. At ENNS (No. 482), 16 km below the weir and 4 km above the mouth of the river, peak discharge would be 1750 m^3/sec above the 220 m^3/sec base flow. Although the wave would remain within banks for most of its travel, the stage at ENNS would be raised 2.5 m and the velocity increased from 2.0 m/sec initially to 4.5 m/sec at the peak. These changes would be rapid, occurring in only about one hour. Slightly lower effects downstream from MUEHLRADING Weir could be expected, if that weir were operated under full pool instead of STANING Weir, since its pool only holds one-half as much water as does STANING. The following tabulation shows critical effects caused by operation of STANING Weir under conditions assumed for this Artificial Flood No. E-2:

		Peak Values-Flood No. E-2				
Station No.	Station Name	Stream Depth (m)	Overflow Height (m)	Width Flooded (m)	Mean Surf. Vel. m/sec	Duration above Bank (Hrs.)
R-51	STANING	14.5	In Banks	210	3.5	0
482	ENNS	5.5	In Banks	150	4.5	0

(8) ENNS River - Artificial Flood No. E-3 is similar to Flood No. E-2, except that in this case the GROSSRAMING Weir (R-47), the farthest upstream of the four existing ENNS River weirs, was considered instead of STANING Weir (R-51). All downstream weirs were considered destroyed and pools empty. The initial peak discharge of 3500 m^3/sec from GROSSRAMING would be practically the same as the 3550 m^3/sec peak discharge from STANING. However, since the storage capacity of GROSSRAMING is 16 hm^3, compared to 10 hm^3 for STANING, the duration of the wave would be longer. Stages at STEYR (No. 467), 33 km downstream from GROSSRAMING, would be increased 4 m. Velocities at the peak would reach 3.5 m/sec. At ENNS (No. 482), 4 km above the DANUBE confluence, the peak discharge would be 1830 m^3/sec, an increase of 1610 m^3/sec above the initial base flow of 220 m^3/sec. This would cause a 3 m rise in stage and an increase of velocity from 2.0 m/sec initially to 4.5 m/sec at the peak. The effects here and at other places below STANING would be practically the same as Flood No. E-2. The wave would remain within banks for most of its travel. The peak would occur within an interval of only 1 to 2 hours after the start of the wave reached ENNS, 2 hours after opening the GROSSRAMING gates. The following table shows critical peak values of Artificial Flood No. E-3 at STEYR and ENNS:

Station No.	Station Name	Stream Depth (m)	Overflow Height (m)	Width Flooded (m)	Mean Surf. Vel. m/sec	Duration above Banks (Hrs.)
		Peak Values-Flood No. E-3				
467	STEYR	7.0	In Banks	120	3.5	0
482	ENNS	5.5	In Banks	130	4.5	0

(9) ENNS River - Artificial Flood No. E-4 represents combined coordinated releases from all four existing ENNS River weirs. All pools were considered full and the gates operative. In order to give maximum combined effects, the opening of gates was assumed to be timed as follows: GROSSRAMING (R-47) at Hr. 0, TERNBERG (R-48) at Hr. 0.5, STANING (R-51) and MUEHLRADING (R-52) at Hr. 1.5. The peak discharges from each weir would be nearly identical, 3500 to 3720 m^3/sec as shown in the summary, Table 6, and on the flood graphs, Plate 11d. The effects would be approximately the same magnitude as from any individual weir (as considered in the previous Floods No. E-2 and E-3) but the duration would be greater due to the greater sustaining influence of the 36 hm^3 volume released from the combined pools. At STEYR (No. 467), the stages would be raised 3 m in about one-half hour, while at ENNS (No. 482), the stages would rise 4.5 m in one hour. It would take about 3 hours for the crest of the wave to travel from GROSSRAMING to ENNS, 4 km above the mouth, with weir openings scheduled as indicated above. Crest stages would remain within banks for most of the course, but velocities would range between 3.5 to 5.0 m/sec during the passage of the peak flow. The following tabulation lists critical values for Flood No. E-4 at several key locations:

Station No.	Station Name	Stream Depth (m)	Overflow Height (m)	Width Flooded (m)	Mean Surf. Vel. (m/sec)	Duration above Banks (Hrs.)
		Peak Values - Flood No. E-4				
467	STEYR	8.0	In Banks	130	3.5	0
482	ENNS	7.0	In Banks	160	4.5	0

4-04 STILLWATER BARRIERS AND DRAINAGE OBSTACLES.

a. General. The studies reviewed in this paragraph pertain to artificial flooding produced by stillwater barriers and drainage obstacles along the main stems of the INN, SALZACH, TRAUN and ENNS Rivers. Studies were largely based on a map study using 1:25,000 or 1:50,000 maps supplemented by topographic data and descriptions contained in References 3, 6, 7, 8, 10 and 12. Exact determination of elevation contours and boundaries was not possible. First-hand information should be obtained by local reconnaissance regarding ground elevations and the locations, elevations, and dimensions of levees, roadfills, culverts and sluices in the vicinity of specific likely sites in order to accurately define the area subject to artificial inundation.

b. Hydrologic Considerations.

(1) The effect of artificial flooding by means of stillwater barriers or drainage obstacles is largely contingent upon the hydrologic conditions prevailing at the time of the operation. The volume of water stored and available within the river basin, the river stage, water-surface gradient, streambed slope, and the rate of flow of the stream are important factors. Reference is made to Sections II and III for description of expected conditions.

(2) The generally steep gradients of these mountainous streams reduces the opportunity for effective use of temporary damming operations for artificial flooding. In the lower reaches and also in certain other relatively flat reaches (less than 2m/km) along the streams, gradients are sufficiently low so that some inundation might be produced by erection of temporary dams to reasonable heights. Reference is made to paragraph 2-05 and to the stream profiles of Plates 3a to 3g for indications of gradients.

(3) Considerable variation exists in stages and flows not only between high and low water but also seasonally, and even from year to year. Reference is made to paragraphs 3-04 and 3-05 and to Plates 6 and 7 for details of these variations. The mean and extreme discharges presented in the following table illustrate the possible range of discharge available for supplying water to stillwater barriers along the lower reaches of the rivers.

	Discharge (m^3/sec)		
River	Maximum	Mean	Minimum
INN	2000-7000	300-700	60-180
SALZACH	1000-3000	100-250	20- 60
TRAUN	1000-2000	100-150	10- 30
ENNS	1000-3000	100-250	20- 50

c. Means of Creating Stillwater Barriers and Drainage Obstacles.

(1) The width and depth of water obstacles afforded by the rivers of the AUSTRIAN ALPS could be increased by utilization of one or more of the following means:

(a) Creation of stillwater barriers by construction of temporary dams at bridge sites, combined with closing of culverts and other openings in levees and road fills.

(b) Increase of extent of pools, upstream from existing dams and weirs, by raising the height of the structure or the operating pool level.

(c) Creation of stillwater barriers by causing artificial landslides to block the stream valley at gorge sections.

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d. Effect of Stillwater Barriers and Drainage Obstacles.

(1) General. Due to the steepness of stream gradients and to the prevalence of high stream banks, temporary dams would have to be generally carried to elevations of 4 to 5 m above normal mean water levels in order to produce stillwater barriers of significant length and width. Formation of continuous barriers is not considered practicable in view of these topographic limitations. Review of potential effects at likely locations for creation of stillwater barriers and drainage obstacles along the INN, SALZACH, TRAUN and ENNS Rivers is discussed in this section of the report.

(2) INN River.

(a) LOWER INN, Mouth (Km 0) to Bavarian-Austrian Border (Km. 219). The pools created by the eight existing power dams along this reach are appreciable water obstacles. Erection of the ten additional proposed dams (or construction of temporary dams at those sites) would create a practically continuous water obstacle. (See Plates 1 and 3c for locations, Table 5 for summary of dam data, Exhibit A for description of these dams, and Plate 9a to 9c for sketches of typical installations). These pools are 6 to 10 m above the normal water level, up to about 1000 m wide, and extend from 5 to 10 km upstream from the dams. While the pool levels might be slightly increased in some cases by raising the crest of the weir gates, no appreciable increase in pool dimensions could be expected.

(b) MIDDLE INN, Bavarian-Austrian Border (Km 219) to INNSBRUCK (Km 298). Some shallow (0.5-1.0 m) inundation of bottom land adjacent to the river could be effected by temporary dams at a few bridges. Widths of resulting flooding would average from 300 to 1000 m and lengths from 1 to 6 km. Breaching of levees during above-normal stages and disruption of drainage facilities would create drainage obstacles in the poorly drained marshy hollows and old meanders between KUFSTEIN (Km. 220) and ROTHOLZ (Km 261), along the lower reaches of the ZILLER River near its mouth (Km. 256), and in the flat-floored valley near INNSBRUCK (Km 298). Erection of temporary dams at suitable bridge openings to heights of 3 to 5 m above mean water level would create shallow flooding (0.5-1.0 m) of bottom lands adjacent to the stream. The widths of flooding would average from 300 to 1000 m and would extend from 1 to 6 km above the sites. Formation of a continuous stillwater barrier would not be practicable and major railroads and highways would not be flooded. The following tabulation illustrates the nature of stillwater barriers at several suitable sites indicated by serial number on Plate 1:

Serial No.	Location	River Km	Pool Dimensions Height (m) above MW	Total length (km)	Average width (m)
B-1	BICHLWANG RR Br.	227	5	6	400
B-2	ANGATH Hwy. Br.	234	3	5	300
B-3	BREITENBACH Hwy. Br.	242	5	2	1000
B-4	BRIXLEGG RR Br.	252	4	5	700
B-5	JENBACH Hwy. Br.	262	4	1	500

(c) UPPER INN, INNSBRUCK (Km. 298) to MARTINSBRUCK (Km. 416). Suitable sites for significant stillwater barriers are scarce in this reach. Banks and roads are high, floodplains are narrow, and stream gradients are fairly steep. Some shallow flooding of bottom lands might be effected by erection of temporary dams at bridges or other constricted sections. Disruption of irrigation and drainage facilities could cause inundation of the numerous small irrigation and drainage projects along the stream from INNSBRUCK (Km 298) nearly to MARTINSBRUCK (Km 416). Upstream from ZIRL (Km 312), the high banks and steep stream gradients make stillwater barriers ineffective. Effects of temporary damming operations are summarized in the following tabulation for several of the more suitable sites:

Serial No.	Location	River Km	Pool Dimensions Height (m) above MW	Total Length (km)	Average width (m)
B-6	KRANEBITTEN Hwy. Br.	304	3	5	400
B-7	ZIRL Hwy. Br.	312	3	2	600

(d) SWISS Portion of INN, Upstream from MARTINSBRUCK. The INN River in this reach is a swift, steep, and narrow mountain torrent. Consequently, no opportunity exists for creation of effective stillwater barriers or drainage obstacles.

(3) SALZACH River.

(a) Mouth (Km 0) to SALZBURG (Km 66). Some flooding of abandoned meanders and bottom lands could be effected by breaching of the extensive system of dikes and other river regulation works in this reach, when river flows were high. No suitable sites for temporary damming exist in the reach from the mouth to BURGHAUSEN (Km 12). The gorge section from that place upstream to PLATTENBURG (Km 22) is likewise unsuitable for stillwater barriers. Temporary dams erected near the upstream end of that gorge or at the ETTENAU-TITTMONING highway bridge (Km 27) would create shallow pools. Breaching of levees in the reach between TITTMONING (Km 27) and SALZBURG (Km. 66) when river stages are 1 to 2 m above MW would flood much of the 1 to 2 km wide meander belt and flood plain. The LAUFEN highway bridge (Km 49) appears to be the only site suitable for temporary dams, since transverse embankments or other constricted sections are lacking in this reach. The following tabulation summarizes the stillwater barrier effects:

4-04d(3)(a)

Serial No.	Location	River Km	Pool Dimensions: Height (m) above MW	Total length (km)	Average width (m)
B-8	PLATTENBURG Gorge	22	3	1	400
B-9	ETTENAU Hwy. Br.	27	2	3	1500
B-10	LAUFEN Hwy. Br.	49	3	3	1000

(b) SALZBURG (Km. 66) to BRUCK (Km 162). No suitable sites for significant stillwater barriers exist in this reach. Some slight increase in stream width might be effected by raising the crest of the HALLEIN weir (Km 83) if permitted by the weir construction. Breaching of levees at above-normal stages and disruption of drainage facilities would cause inundation of old meanders and the poorly drained flood plain of the basin extending upstream to GOLLING (Km 94). The steeper stream gradient and narrow valley above that place, especially in the ST. JOHANN-BRUCK gorge (Km 127-Km 160), minimize the possibility of creating stillwater barriers. It might be possible to block the river by means of landslides. In this connection, it is interesting to note that the valley was inundated for about 2 km upstream from WERFEN (Km 110) in 1947 when the INN was dammed by deposits brought down from the REICHHOFGRABEN, as described in Reference 10.

(c) BRUCK (Km 162) to WALD (Km 210). The wide flat flood plain and relatively flat gradient of this reach (as indicated on the stream profile, Plate 3d), increases its potential for stillwater barrier use. Breaching of dikes and disruption of drainage facilities along the river during above-normal stages would produce inundation of the marshy pastureland and reclaimed bogland in this basin. Erection of temporary dams at constricted sections coupled with levee breaching would likewise produce flooding in this area. A practically continuous stillwater barrier 500 to 1000 m wide could be effected by erection of temporary dams at bridges in the reach between BRUCK (Km 162) and KAPRUN (Km 169), to 3 m above MW at 1 km intervals from there to MITTERSILL (Km 189), and at 0.5 km intervals from there to WALD (Km 209). Pertinent features of resulting stillwater barriers at several suitable sites are contained in the following tabulation:

Serial No.	Location	River Km	Pool Dimensions: Height (m) above MW	Total length (Km)	Average width (m)
B-11	BRUCK RR Br.	162	4	2	1200
B-12	MAYEREINOED Hwy. Br.	165	4	2	1000
B-13	FUERTH Hwy. Br.	167	4	2	600

(d) Upstream from WALD. The gradient is too steep and the valley too narrow in this reach for significant stillwater barriers.

(4) TRAUN River.

(a) Mouth (Km 0) to LAMBACH (Km 47). Breaching of levees and bank revetments along this reach when stages are above normal, would result in inundation of the braided channel area of the TRAUN and MUEHLBACH and their 1 km wide flood plain. However, banks lie from 3 to 5 m above the eroded stream bed and in some places even as high as 10 m. This, coupled with the scarcity of constricted transverse sections and the great lengths of bridge openings, minimizes the possibility for creation of significant stillwater barriers by erection of temporary dams. Raising the crests of the many small mill dams and weirs would not appreciably increase the width of the water obstacle and would merely result in an increase of depth for short distances upstream.

(b) Upstream from LAMBACH. The narrow flood plains and steeper gradients in the upper reaches of the TRAUN basin make creation of significant stillwater barriers impracticable. Raising the level of the lakes by temporary dams would not appreciably increase the area covered by the lake surface.

(5) ENNS River.

(a) Mouth (Km 0) to STEYR (Km 32). Due to the incised nature of the stream bed in this reach, temporary dams would have to be extended to heights of over 5 m to create appreciable width of flooding. Fording of shallow spots would be hindered, however, if the water level were raised by damming. Breaching of levees and bank revetments during periods of high stages would inundate the old river meanders in some cases. Raising the crests of existing dams such as MUEHLRADING (R-52) and STANING (R-51) would not appreciably increase pool widths, as existing pools are defined by levees immediately upstream from the dams. Breaching of these levees would merely cause the water in the pools to bypass the dams, thus resulting in reduction of the pool dimensions. The effect of the flow variations resulting from operation of those dams is discussed in paragraph 4-03.

(b) STEYR (Km 32) to WENG (Km 135). The steep high banks of the river in this reach and the steep gradient, especially in the GESAEUSE gorge section below WENG make creation of stillwater barriers impracticable along this portion of the ENNS River.

(c) WENG (Km 135) to SCHLADMING (Km 213). There does exist some possibility for creation of drainage obstacles in this poorly drained section. Breaching of levees and disruption of drainage facilities during periods of above-normal stages could cause shallow inundation

in the reclaimed marshland and in the abandoned river meanders. Those areas would remain soft for long periods if inundated. Temporary dams erected at suitable bridge sites or other constrictions, coupled with levee breaching and disruption of drainage facilities, would create similar flooding effects. Insufficient topographic data were available to permit definition of resulting flooded areas or height of damming required, but several sites are mentioned in the following tabulation for consideration as likely locations:

Serial No.	River Km.	Location
B-14	134	Near WENG, Blocking of upstream end of GESAEUSE gorge
B-15	141	ADMONT Hwy. Br.
B-16	152	RR Bridge near PALTEN BACH
B-17	159	RR or Hwy. Bridge near LIEZEN
B-18	181	RR Bridge near NIEDEROEBLARN
B-19	200	Hwy. Bridge near AICH

(d) Upstream from SCHLADMING (Km 213). The steep gradient and narrow valley in the MANDLING PASS upstream from SCHLADMING offer but slight possibilities for stillwater barriers. In the flatter stretch near RADSTADT (Km 230), breaching of dikes and disruption of drainage facilities during high river stages would recreate swampy conditions in the reclaimed marshland in that vicinity. Temporary dams erected at suitable constrictions, such as the bridges near RADSTADT (Km 230) would create similar effects if combined with levee breaching and drainage disruption operations. Due to lack of sufficient available topographic information, detailed quantitative analysis of such flooding possibilities was not attempted in this study. No possibilities exist for formation of significant stillwater barriers or drainage obstacles in the steep narrow valley above the junction of LITZLING BACH (Km 237).

e. Water Requirements for Stillwater Barriers.

(1) The volume of water required to create the stillwater barriers described in preceding paragraphs together with the estimated time required for filling each pool at the average rates of flow expected during mean water (MW) conditions are approximately as follows:

River	Site No.	Water Required (million m^3)	Approximate Filling Time (hrs.)
INN	B-1	2.4	2
	B-2	0.8	1
	B-3	2.0	2
	B-4	1.8	2
	B-5	0.2	1
	B-6	1.0	2
	B-7	0.8	2
SALZACH	B-8	0.1	1
	B-9	1.8	2
	B-10	1.5	2
	B-11	1.2	10
	B-12	1.5	9
	B-13	0.5	3
TRAUN		(Sites not suitable)	
ENNS	B-14 to B-19	(Volume not estimated)	

(2) Under low water conditions, it would take up to approximately 5 times as long to fill the stillwater barriers as under mean water conditions. During high water, the required times would be considerably reduced as the extreme flood flows are as much as 10 times as great as mean water flows.

(3) Water stored in the hydroelectric reservoirs listed in Table 5 would be available for supplementing natural flows for filling of stillwater barriers and creating drainage obstacles. However, the headwater reservoirs are mostly small and do not store much water. The lakes of the TRAUN basin and the pools behind the weirs in the lower reaches of the INN and ENNS Rivers contain appreciable volumes which might be utilized to provide water to inundate marshy areas if the protective dikes were breached. Reference is made to Table 5 and to paragraphs 4-02 and 4-03 for data and discussion of the volume of water that could be released from these structures and the resulting discharges and stages.

4-05 ARTIFICIAL FLOODING POTENTIALITIES OF CANALS AND LAKES.

a. Canals. Blocking of drainage canals and channels, coupled with breaching of dikes and destruction of drainage pumps could create "drainage obstacles" in reclaimed marshy areas and old river meanders as described in paragraph 4-04. Breaching of power canals, conduits, and aqueducts at stream crossings or at locations elevated above the surrounding terrain might cause some local flooding as well as small increases of stage and velocity in the streams immediately below the breach.

b. Lakes. Possibility of utilization of the large volumes of water stored in the deep glacial lakes of the region, described in paragraph 2-13, for artificial flooding is considerably reduced by the constricted size of outlet streams and by their bottom elevations lying close to the normal lake water surfaces. Raising of lake levels by damming the outlets would increase the volume available for release but would require from about a week to several months for filling at normal rates of inflow, as indicated in paragraph 4-02c for the lakes of the TRAUN River basin, in which basin most of the lakes are concentrated. Artificial flood waves from the lakes of the TRAUN basin are discussed in paragraph 4-02.

4-06 SUMMARY.

a. General. The hydraulic features associated with artificial flooding along the streams covered by this report, as described in preceding paragraphs 4-01 through 4-05, are herein summarized. Reference should be made to Section V of this report for discussion of associated influence upon military operations.

(1) Major Flood Waves. Breaching of the dam structures of the larger hydroelectric power reservoirs located in the headwaters would create "major flood waves." The height and length of the artificial waves depends largely upon the volume of water released from the reservoir. In this study, detailed analysis was only made of the effect of breaching those existing dams in each basin that have the largest reservoir capacity. Breaching those dams probably would produce the maximum probable artificial flood waves. In order to produce significant flood waves along the major streams by use of the smaller reservoirs, coordinated breaching of several dams would be necessary. Reference is made to paragraph 4-02 for discussion of effects of major flood waves studied in the LOWER INN, SALZACH, TRAUN and ENNS River basins, to Table 6 for summary of data, and to Plates 11b to 11d for flood wave graphs. Subsequent paragraphs 4-06b to 4-06e summarize the potentialities of major flood waves in individual river basins.

(2) Streamflow Variations. Sudden opening of the large flood gates of the "run-of-the-river" weirs in the lower INN and ENNS Rivers would create significant variations in stages and velocities. Overbank flooding would occur at low-lying locations, stages would approach bankfull for most of the course, and the rate of rise of stage and velocity would be quite fast. Reference is made to paragraph 4-03 for discussion of streamflow variations, to Table 6 for summary of effects, and to Plates 11a and 11d, for flood graphs. Opening of outlets of other hydroelectric and mill dams, listed in Table 5 or described in Exhibits A to D, would probably not produce significant streamflow variations except immediately downstream from the structures, as the

resulting discharge rates in most cases are small relative to the stream channel capacities. The released water, however, might be used to supplement natural flows for filling of stillwater barriers and for refilling of weir pools emptied for streamflow variations. Subsequent paragraphs contain a summary of effects of streamflow variations for individual river basins.

(3) Stillwater Barriers and Drainage Obstacles. Erection of temporary dams at bridge openings or other constricted sections to create stillwater barriers would be effective only at a few places in the flatter reaches of the streams. Formation of a continuous effective water obstacle by this means would not be practicable. The generally steep gradients of the streams render this means of artificial flooding relatively ineffective. Breaching of levees and disruption of drainage facilities when stages are above normal would create drainage obstacles by causing shallow inundation or swampy conditions in the low-lying reclaimed marshland and abandoned river meanders that exist along various reaches of the streams in this region. Reference is made to paragraph 4-04 for discussion of effects of stillwater barriers and drainage obstacles at specific sites. Subsequent paragraphs contain summary of effects for individual river basins.

(4) Destruction of Temporary Dams. Demolition or failure of the temporary dams used for stillwater barriers would produce flood waves of short duration and magnitude, but significant effects would only prevail for a few kilometers below the destroyed structure. Adequate relief spillways or outlets should be provided in any temporary dam to reduce the chance of untimely failure due to water overtopping the structure.

(5) Canals. Blocking of drainage canals, breaching of dikes, and destruction of drainage pumps could cause shallow inundation of reclaimed marshy areas and abandoned river meander-beds as described in paragraphs 4-04 and 4-05. Breaching of power canals and conduits, could create local inundation and variation in stage and velocity, but effects would be slight in most cases. However, the released water might supplement natural flow as a source of supply for stillwater barriers and refilling of weir pools that had been emptied by opening of gates to create the streamflow variations discussed in preceding paragraphs.

b. INN River.

(1) Major Flood Waves. The volume of water impounded by the many hydroelectric power dams now existing in the headwater of this basin are too small to produce significant flood waves, except immediately downstream from a breached dam. Opening the gates of the "run-of-the-river" weirs along the LOWER INN would produce large "streamflow variations" summarized in the next subparagraph.

(2) Streamflow Variations. The large discharge capacities of the flood gates of the "run-of-the-river" weirs in the lower reaches of the INN River affords an excellent opportunity for creating large and rapid streamflow variations by sudden opening of the gates. Numerous combinations of gate operations at various weirs could be made. In general, combined operation of several weirs would not greatly change the effects immediately downstream from individual weirs. However, the greater volume of water involved in combined operations would tend to sustain the duration and peak discharges as he wave traveled downstream. Cyclic variations could likewise be created by various combinations of gate opening and closing operations and by transfer of water from upstream pools to dowstream pools. For example, cyclic operations at JETTENBACH Weir (R-12) could be repeated about every 2 hours for about 24 hours total, by transfer of water from upstream pools; or could be repeated approximately every 4 hours for as long as mean water conditions prevailed. In this connection, reference is made to the estimated refilling times listed in paragraph 4-03b. Completion of additional weirs, now under construction or proposed (as indicated on Plate 3c and discussed in paragraph A-08 of Exhibit A), would increase possible combinations along the LOWER INN River. Reference is made to Table 6 for summary of effects, to Plate 11a, for flood graphs, and to Paragraph 4-03d for discussion of various streamflow variations considered in this study. Reference is also made to Paragraph A-05 of Exhibit A for discussion of similar streamflow variations as studied by the German Army. Representative effects of Artificial Flood No. I-2, representing combined releases from all existing weirs on the LOWER INN River, are presented in the following tabulations to indicate the maximum probable effects attainable:

Artificial Flood No. I-2

Item	Unit	ROSENHEIM No. G-2(Km 184)	BRAUNAU No. 282(Km 58)	WERNSTEIN No. G-5(Km 8)
Amplitude of rise	m	1.0	6.0	7.5
Rate of rise	m/hr	0.3	*	1.2
Time of crest	hr	4	9	16
Overflow height	m	In Banks	1.5	3.5
Width flooded	m	300	1000	400
Mean surf. vel. at crest	m/sec	2.5	3.5	5.0

* Practically instantaneous, less than one-half hour.

(3) Stillwater Barriers and Drainage Obstacles. The pools formed by the power dams across the lower reaches of the INN River in themselves are appreciable water obstacles. Temporary dams at bridges in the reach between KUFSTEIN (Km 220) and JENBACH (Km 262) and above INNSBRUCK (Km 298) would create short stillwater barriers about 1 to 6 km long, 300 to 1000 m wide, and averaging 0.5 to 1.0 m deep over the

flood plain. Breaching of levees and disruption of drainage facilities in those vicinities would create drainage obstacles in reclaimed marshy areas. Reference is made to paragraph 4-04d(2) for more detailed discussion.

c. SALZACH River.

(1) Major Flood Waves. Breaching of the LIMBERG Dam (R-27), located on the KAPRUNER ACHE 11 km above the SALZACH confluence at Km 166, would produce a major flood wave that would overtop the banks and create high velocities along the SALZACH. The effect of this wave along the INN River below the SALZACH junction would be slight. The flood waves created by breaching other dams in this basin would not be significant except on the tributary streams immediately downstream of the breached structures. Summary of effects of the flood wave produced by breaching LIMBERG Dam, designated as Flood No. S-1 is contained in Table 6, sketches of the dam are shown on Plate 9d, flood graphs on Plate 11b, and discussion is contained in paragraph 4-02d. The following tabulation affords an idea of the magnitude and nature of the effects produced by this artificial Flood Wave No. S-1:

Artificial Flood No. S-1

Item	Unit	206, BRUCK i.P. SALZACH Km 161	281, ACH SALZACH Km 11	G-5, WERNSTEIN INN Km 8
Amplitude of rise	m	6.0	4.0	2.0
Rate of rise	m/hr	6.0	1.0	0.3
Time of crest	hr	1	14	25
Overflow height	m	2.0	1.5	In Banks
Width flooded	m	1000	800	300
Mean surf. vel. at crest	m/sec	5.0	4.0	3.0

(2) Streamflow Variations. Variations in stage, velocity, and stream width caused by releases of water from the outlets of dams in the basin would be slight, except immediately downstream of the structures. Consequently, no analysis of streamflow variations was made in this basin.

(3) Stillwater Barriers and Drainage Obstacles. Inundation of abandoned meanders and reclaimed marshy bottom land could be achieved by breaching levees and disrupting drainage facilities near TITTMONING (Km 271), in the HALLEIN basin (Km 83-94), and in the valley from BRUCK (Km 162) to WALD (Km 209), during periods of above-normal stages. Associated raising of river stages by erection of temporary dams at suitable constricted sections in those reaches would facilitate such flooding and create stillwater barriers from 1 to 3 km long and 400 to 1500 m wide. Reference is made to paragraph 4-04d(3) for more detailed discussion.

d. TRAUN River.

(1) Major Flood Waves. While the many lakes in the TRAUN basin store enormous volumes of water, the constricted size of outlet streams and their location near the top surface of the deep lakes greatly reduces the volume available for discharge. In order to create flood waves of significant peak height, it would be necessary to artificially raise the lake levels to several meters above normal by the constructing of special temporary dams at the outlets. Breaching of the dams would release waves of considerable duration. However, it would be necessary to combine waves from at least the two largest lakes, the TRAUN SEE and ATTER SEE, in order to produce appreciable overbank flooding in the lower reaches of the TRAUN and AGER Rivers. Breaching of similar dams at other lakes, especially if normal lake levels are raised, would increase the depths and velocities of the streams downstream from those lakes and could increase the duration of discharge from the TRAUN SEE and ATTER SEE. Reference is made to paragraphs 4-02d for discussion of the effects of three major flood waves studied, to Plate 11c for the flood wave graphs, and to Table 6 for summary of effects. Representative effects of Artificial Flood No. T-3, the largest of those studied and involving combined releases from five of the larger lakes at augmented lake levels, are presented in the following tabulation:

Artificial Flood No. T-3

Item	Unit	LAMBACH No. 391 (Km 47)	EBELSBERG No. 404 (Km 5)
Amplitude of rise	m	4.0	3.0
Rate of rise	m/hr	2.0	0.6
Time of crest	hr	12	20
Overflow height	m	0.5	1.0
Width flooded	m	150	700
Mean surf. vel. at crest	m/sec	3.0	3.0

(2) Streamflow Variations. Releases from the regulated outlets of the many small weirs in this basin would not produce significant streamflow variations except shortly downstream of the outlets. Combined coordinated releases from a number of weirs would extend the duration as discussed in paragraph 4-03d(6).

(3) Stillwater Barriers and Drainage Obstacles. Breaching of levees during periods of above-normal stages would inundate the 1 km wide braided channel area in the lower 47 km below LAMBACH. Suitable sites for creation of stillwater barriers by temporary damming operations are practically non-existent along the TRAUN River. Additional discussion appears in paragraph 4-04d(4).

e. ENNS River.

(1) Major Flood Waves. Breaching of the SALZA Dam (R-46), located on the SALZABACH 6 km above its junction with the ENNS at Km 182, would produce a major flood wave on the ENNS. Except near the mouth of the SALZABACH, banks would not be overtopped, but peak velocities would approach 3.5 m/sec in places and the increase in stages would range between 3.5 in the upper reaches to 1.0 m in the lower reaches of the ENNS, assuming the "run-of-the-river" weirs in the lower reaches as destroyed and their pools empty. Flow from the breached SALZA Dam, combined with releases from those weirs, would not greatly change the magnitude of "streamflow variations," designated as Floods E-2, E-3, and E-4, and discussed in the next subparagraph, but would slightly increase their duration. Reference is made to Table 6 for summary of effects of the flood wave (Flood No. E-1) created by breaching SALZA Dam, to Plate 11d for flood graphs and to paragraph 4-02d for further discussion. Due to small volumes of water impounded by other headwater mill dams or weirs in the ENNS basin, breaching of the structures would not create significant effects on the ENNS itself, although effects might be appreciable on the tributaries for short distances downstream from the breached structures. The following tabulation indicates the nature of the flood wave produced by breaching SALZA Dam:

Artificial Flood No. E-1

Item	Unit	439, WENG Km 135	467, STEYR Km 31	482, ENNS Km 4
Amplitude of rise	m	3.5	1.5	1.0
Rate of rise	m/hr	1.2	0.5	0.3
Time of crest	hr	9	15	17
Overflow height	m	Bankfull	In Banks	In Banks
Width flooded	m	60	110	140
Mean surf. vel. at crest	m/sec	3.0	2.0	3.0

(2) Streamflow Variations. Rapid and large variations in stage and velocity could be effected by sudden opening of the large gates of one or several of the four existing "run-of-the-river" weirs located in the lower 65 km of the ENNS River. Combined operation of the weirs would tend to sustain the duration of high stages but would not greatly increase the height of the wave over that produced by operation of individual weirs singly. Cyclic variations could be produced by refilling of the pools by means of natural flow, by transfer of water from upstream to downstream pools, and by releases from outlets of headwater reservoirs. For example, releases from MUEHLRADING (R-52) could be repeated approximately every 2 hours for about 12 hours by transfer of water from upstream pools; or could be repeated about every 6 hours under mean water conditions of inflow to

refill the emptied pool. Completion of additional weirs, now being built or proposed (as indicated in Table 5 and discussed in paragraph D-07 of Exhibit D) would increase the number of possible combinations. Reference is made to summary of effects in Table 6, to flood graphs of Plate 11d, and to discussion of effects in paragraph 4-03d. Representative effects of Artificial Flood No. E-4, representing combined operation of the four existing weirs, are presented in the following tabulation to indicate maximum probable effects now attainable:

<u>Artificial Flood No. E-4</u>

Item	Unit	467, STEYR Km 31	482, ENNS Km 4
Amplitude of rise	m	5.0	4.5
Rate of rise	m/hr	10.0	4.5
Time of crest	hr	2	3
Overflow height	m	In Banks	In Banks
Width flooded	m	130	160
Mean surf. vel. at crest	m/sec	2.0	3.0

(3) <u>Stillwater Barriers and Drainage Obstacles.</u> In the lower 30 km reach of the ENNS and in the relatively flat reach between WENG (Km 135) to SCHLADMING (Km 213), drainage obstacles might be created by breaching of levees and disruption of drainage facilities to inundate old river meanders and reclaimed marshy areas. Blocking of the valley by temporary dams at constricted sections between WENG and SCHLADMING would create stillwater barriers of similar effect. Paragraph 4-04d(5) contains more detailed description of effects.

SECTION V

EFFECT ON MILITARY OPERATIONS

5-01 GENERAL.

The purpose of this section is to present various items for consideration of military planning personnel in estimating the relative value and effect of artificial floods upon associated military factors such as bridging, ferrying, and trafficability. The effects of artificial floods upon military operations may vary greatly, depending on the hydrologic and weather conditions, the tactical and logistical situation, and the type of equipment involved. Reference is made to Section IV for discussion of the hydraulic features associated with artificial flooding.

5-02 CHARACTERISTICS OF MILITARY BRIDGING.

a. The loading capacities of standard U. S. Army floating bridging under conditions classified as "Safe, Caution, and Risk Crossings," for various current velocities are tabulated in Table 7. Included are the current velocities that presumably would destroy the bridge in place with no load, the values ranging from 9 to 16 feet per second (i.e. about 2.7 to 4.9 m/sec). Table 7 is primarily based on data contained in References 91 and 92.

b. It should be noted that the velocities shown in Table 7 represent general averages. The ability of floating bridges to withstand current velocities depends upon numerous variable factors such as: special provisions for securing the bridge, the rate of change in river stage, direction and variability of current, debris carried by the stream and other considerations. Standard bridging has withstood conditions more severe than indicated in Table 7 and has failed under apparently less critical velocities.

5-03 EFFECTS OF ARTIFICIAL FLOODING DURING ACTUAL CROSSING OPERATIONS.

No information was available regarding the influence of artificial flooding upon actual military crossing operations.

5-04 EFFECT OF MAJOR FLOOD WAVES.

a. Reference is made to paragraphs 4-02 and 4-06 for discussion of hydraulic features of major artificial flood waves that could be produced on the INN, SALZACH, TRAUN and ENNS Rivers by breaching existing or temporary dams. Hydraulic effects of the representative major artificial flood waves studied are summarized in Table 6 and presented graphically on Plates 11a to 11d.

b. Flood waves created by breaching would probably seriously damage or possibly even destroy fixed and floating bridges located short distances below the breached structures. Farther downstream, damage to fixed bridges would not be as likely, but floating bridging might be endangered.

c. Dams, weirs, levees, and revetments located downstream of the breached structure might fail, especially in cases where they would be overtopped by the artificial flood wave. Such failures could intensify the damaging effects of the flood wave, and cause inundation and other damage in areas protected by those dikes or revetments.

d. Floating bridging, ferrying, or fording operations would be hindered in some cases by the increased flow velocities and by the rapid rise and fall of stage during the passage of the wave.

e. The short duration of the wave crests would reduce the interference with military operations caused by increased velocity or stage, to a matter of only a few hours. Where bridges were destroyed or damaged, the hindering effect could be more prolonged.

f. Logs and other debris, floating ice, floating mines, flaming napalm, or perhaps even radio-active material carried along by the flood wave could seriously increase the effect on floating or fixed bridging and military crossing operations.

g. Since the electrical power supply of AUSTRIA and adjacent territories is largely dependent upon the hydroelectric installations in this region, breaching of dams and associated works would seriously disrupt the power supply for cities, industries and electrified railways.

h. The possibility of breaching of a dam could have a deterrent upon river crossing attempts in some cases. Deliberate destruction of a dam or emptying of the reservoir would prevent its use by the enemy to deter crossing attempts or to produce detrimental flood waves during a later critical period.

i. Demolition of landslides blocking a stream could produce major artificial flood waves. The nature, magnitude, and duration of effects would vary with the location, height, and volume of water stored behind the streamblock. Landslides might occur naturally or be produced by artificial means in some narrow gorge sections.

5-05 EFFECT OF STREAMFLOW VARIATIONS.

a. Discussion of hydraulic effects of streamflow variation that might be produced on the major rivers of theAUSTRIAN ALPS by regulated discharge from the outlets of dams and weirs are covered in paragraphs 4-03 and 4-06. Reference is also made to Table 6 for summary of hydraulic effects and to Plates 11a, c and d for graphical presentation of hydraulic effects of the streamflow variations analyzed in this report.

b. Sudden opening of the flood gates of the "run-of-the-river" hydroelectric weirs along the lower reaches of the INN and ENNS Rivers would produce streamflow variations, whose rapid and large rise and fall of stage and velocity would seriously hinder floating bridging, ferrying or fording operations.

c. Duration, timing, and magnitude of those streamflow variations could be varied in a very flexible manner by various combinations of releases from the weirs. Cyclic variations by means of scheduled opening and closing of gates and transfer of water downstream from pool to pool, could readily be produced and would prolong the hindrance to crossing operations. However, any reduction of duration and released volume would likewise decrease the magnitude and duration of high stages and velocities.

d. Damages to floating bridges and interference with crossing operations by these flow variations might be intensified if ice floes, large debris, mines, or flaming napalm were carried downstream by the released flows.

e. Breaching of levees and destruction of drainage and irrigation facilities in connection with production of streamflow variations might be desirable in some cases to widen the area flooded.

f. Trafficability at stream approaches and across inundated areas would be hindered during the passage of the crest of the flow variation. In some cases, areas once inundated would remain muddy or marshy for some time afterwards.

g. Deliberate destruction of the structures or gates of the INN and ENNS weirs would prevent their use by the enemy in producing detrimental flow variations at a later critical period, and would also seriously disrupt electrical power facilities. Emptying of the pools would have similar effects, but the duration would depend upon the rate at which the pools could be refilled.

h. In order that the gated openings of the weirs would be available for production of detrimental streamflow variations, the sites would have to be protected against damage or destruction by sabotage, bombing, or enemy ground attacks.

i. No appreciable effect on bridging or crossing operations could be expected by releases of water from the small power outlets of the headwater hydroelectric dams. However, emptying of these reservoirs or destruction of the dams or powerplants, would disrupt the power supply of the region.

5-06 EFFECT OF STILLWATER BARRIERS AND DRAINAGE OBSTACLES.

a. Reference is made to paragraphs 4-04 and 4-06 for discussion of the hydraulic features associated with formation and augmentation of

water obstacles by means of temporary damming operations or by disruption of normal drainage along the various major rivers of the AUSTRIAN ALPS.

b. In general, the mountainous terrain of the region offers few suitable sites for artificial increase of the water obstacle afforded by the natural streams. Some increase in width and depth of the streams to hinder bridging, ferrying or fording operations could be effected by erection of temporary dams in the vicinity of sites described in paragraph 4-04.

c. The pools formed by the dams and weirs across the streams, especially on the lower flatter reaches, constitute appreciable water obstacles to military crossing operations if water levels are maintained near the normal pool. Increase of pool heights by raising dam crests would not appreciably increase the obstacle value. Emptying of the pools could facilitate crossing operations by decreasing depths and widths, but approaches might remain muddy.

d. Overland and river approach trafficability and maneuverability in the old meander belts and low-lying reclaimed marshy areas adjacent to the rivers in the lower reaches and in some of the wider basins could be hindered by breaching of local flood protection levees and disruption of normal drainage facilities, especially during periods of above-normal river stages. Once wet, these areas would remain soft for extended periods.

e. Movement on railroads and roads along the river valleys might be obstructed by creation of landslides to block the river valleys and form pools in some of the narrow gorges.

f. Destruction of temporary or permanent dams or valley blocks by natural failure or by demolition would release flood waves of short duration that would temporarily hinder crossing operations for short distances below the structure and which might cause progressive failure of other downstream dams. Continuous military support would be necessary to prevent untimely destruction by enemy action.

g. The effect of stillwater barriers and drainage obstacles might be intensified by location of underwater obstacles and mine fields beneath the inundated area or along its approaches to further hinder crossing operations or attacks upon the installation.

5-07 EFFECTS RELATED TO OTHER BASINS.

a. Artificial flooding in this region could be coordinated with similar operations in other nearby river basins to create simultaneous or progressive water obstacles affecting military operations. Artificial floods produced on the INN, SALZACH, TRAUN and ENNS might be combined with those on other tributaries of the DANUBE to produce significant flooding on the DANUBE. However, such studies were beyond the scope of this report. A study of artificial flooding effects of regulation,

operation or possible demolition of the KACHLET Dam on the DANUBE River near PASSAU has been made by this office and is cited as Reference 93 in the Bibliography of this report.

b. Specific reference is made to similar studies made by this office on the DRAU (DRAVA), MUR (MURA) and SAVA Basins of Austria and Yugoslavia, and the ISONZO, TAGLIAMENTO, LIVENZA, PIAVE, BRENTA, BACCHIGLIONE and ADIGE Basins in the VENETIAN-FRIULI PLAINS of NORTHEAST ITALY. These basins lie across the Alpine ridge, south of the region covered by this report on the AUSTRIAN ALPS. The reports on artificial flooding potentialities in those regions are listed as References 94 and 96 in the Bibliography.

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TABLES

TABLE I
EQUIVALENT ENGLISH-METRIC TERMS

To reduce A to B, multiply A by F. To reduce B to A, multiply B by G.

Unit A	Factor F	Factor G	Unit B
	LENGTH		
Miles	1.60935	.62137	Kilometers
Meters	3.2808	.30480	Feet
Meters	39.370	.025400	Inches
	AREA		
Square Miles	2.590	.3861	Square Kilometers
Square Miles	259.000	.0038610	Hectares
Hectares	2.47104	.40469	Acres
Acres	4046.9	.00024710	Square Meters
	VOLUME		
Cubic Meters	35.3145	.028317	Cubic Feet
Cubic Feet	28.317	.035314	Liters
Acre-feet	43560.	.000022957	Cubic Feet
Acre-feet	1233.5	.00081071	Cubic Meters
	DISCHARGE		
Cubic feet per second	1.9835	.50417	Acre-feet per 24 hours
Cubic meters per second	35.3145	.028317	Cubic-feet per second
	VELOCITY		
Miles per hour	1.60935	.62137	Kilometers per hour
Miles per hour	1.4667	.68182	Feet per second
Meters per second	3.2808	.30480	Feet per second
Meters per second	2.2369	.44704	Miles per hour
Meters per second	3.600	.2778	Kilometers per hour
Feet per second	1.097	.9113	Kilometers per hour
	WEIGHT		
Tons (metric)	1.102	.9072	Tons (short)
Tons (long)	1.016	.9842	Tons (metric)
Tons (metric)	2205.	.0004536	Pounds (avoirdupois)
Tons (metric)	1000.	.001	Kilograms
	POWER		
Horsepower (std. U.S.)	550.	.0018182	Foot-pounds per second
Horsepower (metric)	75.	.01333	Kilogram-meters per second
Horsepower (std. U.S.)	1.014	.9863	Horsepower (metric)
Kilowatts	1.3405	.7457	Horsepower (std. U.S.)
Kilowatts	1.360	.7355	Horsepower (metric)

TABLE 2

HYDROLOGIC TERMS AND ABBREVIATIONS

(In conformance with German practice)

Non-Tidal Stage	High-Tide Stage	Low-Tide Stage	Rate of Discharge (m^3/sec)	Discharge per Unit area (1/sec-km^2)	Definition
HHW	HHThw	HHTnw	HHQ	HHq	Highest value ever known or observed
HW	HThw	HTnw	HQ	Hq	Highest value observed during a stated period of time
MHW	MHThw	MHTnw	MHQ	MHq	The mean high value during a stated period, derived by averaging the highest values of each unit time element (i.e. MHW 1926/35 is average of the 10 yearly peak stages)
MW	MThw	MTnw	MQ	Mq	The mean (arithmetical average) of all observations during a stated time period
MNW	MNThw	MNTnw	MNQ	MNq	The mean low value during a stated period, derived by averaging the lowest values of each unit time element (MNW 1926/35 is the average of the 10 yearly lowest stages)
NW	NThw	NTnw	NQ	Nq	Lowest value observed during a stated period of time
NNW	NNThw	NNTnw	NNQ	NNq	Lowest value ever known or observed

TABLE 3

MAP COVERAGE - AUSTRIAN ALPS

Scale	Series Number AMS	Series Number GSGS	Sheet Numbers
1:250,000	M508	4346	L48, L49, M48, N48, N49, O48, O49
	M591	4230	4, 5
1:100,000	M641	4416	W6, W7, X6, X7, Y5 to Y7, Z4 to Z7
	M671	4416	W8, X8, X9, Y8, Y9
	M691	4164	1, 1A, 2, 3, 4, 4A, 4B
1:50,000	M742	4472	65W&E, 66W&E, 71W&E, 72W&E, 73W&E, 78W&E, 79W&E, 84W&E, 85W&E, 86, 92W&E, 93W&E, 94, 97W&E, 98, 99, 100
	M771	4529	W7, W8, X7, X8, X9, Y6, Y7, Y8, Y9, Z4, Z5, Z6, Z7, Z8 (each divided into eighths numbered 1 to 8), 5244W&E, 5245W
	M791	4229	1-III, 1-II, 2A-III, 3A-II
1:25,000*	M842	4497	568, 569, 570, 571, 595, 598/599, 626, 627/628, 650 to 655, 673 to 679, 696 to 702, 718 to 724, 740 to 747, 763 to 772, 786 to 796, 814 to 823, 842 to 845, 848 to 850, 869, 870, 882
	M871	4528	27, 28, 44, 45, 46, 63, 64, 87 to 90, 93, 94, 115 to 120, 124, 125, 142 to 151, 153 to 155, 169 to 174, 176 (each divided into quadrants numbered 1 to 4)
	M895	4732	498BIS, 498, 499, 517, 518, 519, 536, 537, 538 (each divided into quadrants lettered NW, NE, SW, SE)

CAPTURED AUSTRIAN MAPS

Scale	AMS Call Number	Sheet Numbers
1:25,000*	17M . -30-49005-25	63 to 66, 71, 93 to 96, 123 to 127, 148, 149, 151 to 155 (each divided into quadrants numbered 1 to 4)

* Available 1:25,000 maps provide coverage for only part of area within scope of this report.

TABLE 4

SUMMARY OF GAGE DATA

Gage No. (1)	Gage Name	River	River km (2)	Map Sheet (3)	UTM Coordinates	Year Established	Elevation Gage Zero m.ü.A.	Drainage Area Km^2	Maximum(H	
									cm	D
INN RIVER BASIN										
G-1(6)	MARTINSBRUCK	INN	416.3	5(M591)	PS1193	1895	1027.15	19,453	463	23/9
116	MAGERBACH (5)	INN	342.3	M-48	PT4335	1886	653.91	5,119	470	8/7/
121	INNSBRUCK (5)	INN	297.6	M-48	PT8137	1870	568.43	5,794	543	1871
142	SCHWAZ (5)	INN	269.3	M-48	QT0447	1844	532.10	7,126	566	1865
170	REISACH (7)	INN	208.5	M-48	TN8882	1861	465.62	9,793	368	1871
G-2(6)	ROSENHEIM	INN	184.5	M-48	TP8604	1938	440.24(8)	11,284	580	5/31
G-3(6)	WASSERBURG (FERRY)	INN	157.1	M-49	TP9327	1927	420.11(8)	12,013	531	1899
G-4(6)	NEUOETTING	INN	92.0	N-49	UP2847	1826	360.54(8)	13,151	805	1899
282	BRAUNAU	INN	58.3	N-49	UP5447	1851	332.45	22,926	880	1899
297	SCHARDING	INN	16.2	N-49	UP8468	1851	299.79	25,664	1160	1899
G-5(6)	WERNSTEIN	INN	7.6	N-49	UP8673	1901	293.86	26,072	1057	1899

(1) Gage serial number - See General Map, Plate 1 and River Basin Maps, Plate 2
(2) Above river mouth
(3) AMS series M508, scale 1:250,000
(4) Items in parentheses estimated
* Not available
(5) Discrepancy in gage zeros and kilometers quoted in 1948 JAHRBUCH and in KADASTER (1950); stages ar
on KADASTER gage zeros.
(6) Serial number assigned for this report; not an official gage number
(7) Elevation and kilometer datum used are based on Austrian Kadaster, rather than German Jahrbuch
(8) Based on German "DEUTSCHES GEWAESSER KUNDLICHES JAHRBUCH, 1950", elevations are above "Normal Null
approximately 0.4m must be added to m+NN)

TA

	Gage Height(4)				Discharge(4)					
(HHW)	Mean Annual(MW)		Minimum(NNW)		Maximum(HHQ)		Mean Annual(MQ)		Minimum(NNQ)	
Date	cm	Period	cm	Date	m^3/sec	Date	m^3/sec	Period	m^3/sec	Date
3/9/20	244	1931-40	182	23/3/39	533	1920	61.2	1931-40	9.6	1909
/7/40	170	1931-40	68	25/3/44	(1100)	1940	156	1931-40	(12)	1944
1871	166	1931-40	64	10/4/00	(1250)	1871	160	1931-40	(15)	1900
1865	208	1929-38	70	1889	*	*	209	1929-38	*	*
1871	-219	1941-50	-340	28/12/44	1950	31/5/40	310	1929-38	63.0	16/2/01
/31/40	127	1941-50	-7	6/2/39	2500	1940	317	1941-50	64.8	19/12/43
1899	114	1926-35	0	1895	2760	1899	363	1926-35	75	2/14/29
1899	260	1926-35	-90	15/2/29	3000	1899	374	1931-45	80	15/2/29
1899	325	1940-44	50	1858	(7700)	1899	678	1940-44	(55)	1858
1899	*	*	15	1866	(6000)	1899	*	*	(150)	1866
1899	196	1941-50	25	17/12/21	7000	1899	734	1921-50	184	6/12/45

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and kilometers shown are based

ull" (to convert to m.ü.A.,

TABLE 4

SUMMARY OF GAGE DATA

Gage No. (1)	Gage Name	River	River Km (2)	Map Sheet (3)	UTM Coordinates	Year Established	Elevation Gage Zero m.ü.A.	Drainage Area Km²	Maximum (HHW) cm	Date
SALZACH RIVER BASIN										
188	WALD IM PINZGAU	SALZACH	209.6	N-48	TN9036	1901	863.03	185	340	7/7/46
196	MITTERSILL	SALZACH	188.6	N-48	UN0939	1891	783.03	591	420	2/8/37
201	NIEDERSILL	SALZACH	175.7	N-48	UN2039	1895	763.66	918	390	14/6/1
206	BRUCK IM PINZGAU(5)	SALZACH	161.4	N-48	UN3539	1891	746.14	1167	518	*
212	RAURIS-KITZLOCH(5)	SALZACH	149.1	N-48	UN4640	1895	687.91	1424	370	1918
232	ST. JOHANN IM PONGAU(5)	SALZACH	127.5	N-48	UN6345	1880	559.04	2595	443	20/7/
237	WERFEN	SALZACH	110.9	N-48	UN6360	1880	518.42	2945	(550)	10/7/4
246	GOLLING(5)	SALZACH	93.6	N-48	UN6273	1895	463.16	3561	480	7/19/2
249	HALLEIN(5)	SALZACH	79.7	N-48	UN5683	1895	433.17	3901	750	1899
251	SALZBURG(5)	SALZACH	66.3	N-48	UN5397	1822	412.60	4406	810	1899
277	NEUOBERNDORF(5)	SALZACH	48.7	N-48	UP4612	1906	389.91	6105	874	7/9/20
280	ETTENAU(5)	SALZACH	27.0	N-49	UP3426	1851	365.62	6628	630	7/9/20
281	ACH(5)	SALZACH	11.4	N-49	UP3836	1895	351.65	6690	960	1899

See Notes on page 1

(MHW)	Gage Height (4)				Discharge (4)					
	Mean Annual (MW)		Minimum (MNW)		Maximum (MHQ)		Mean Annual (MQ)		Minimum (MNQ)	
Date	cm	Period	cm	Date	m^3/sec	Date	m^3/sec	Period	m^3/sec	Date
/46	156	1925-32	60	26/2/42	(100)	1946	6.6	1925-32	*	1942
/37	187	1925-32	75	3/11/47	(250)	1937	26.4	1925-32	*	1947
6/19	160	1925-32	60	30/1/47	(312)	1919	38.2	1925-32	*	1947
*	212	1930-39	120	1930	(354)	*	44.0	1930-39	6.0	1930
8	168	1930-39	95	*	(405)	*	55.0	1930-39	10.0	1918
7/31	177	1930-39	91	*	716	1931	97.0	1930-39	15.0	*
7/47	151	1930-39	43	1896	(900)	1947	110	1930-39	(10)	1896
9/20	154	1930-39	65	27/2/01	1300	1920	136	1930-39	25.0	1901
9	157	1931-35	143	*	1800	1899	147	1931-35	21.1	*
9	199	1930-35	40	9/1/44	2250	1899	172	1930-35	26.0	1931
/20	226	*	-69	22/1/37	(3200)	1920	224	*	42.1	1937
/20	282	*	19	1871	(3200)	1920	248	*	56.3	1871
9	208	1931-37	96	24/2/01	3400	1899	251	1931-37	58.4	1901

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WASHINGTON DISTRICT, CORPS OF ENGINEERS
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TABLE 4

SUMMARY OF GAGE DATA

Gage No. (1)	Gage Name	River	River Km (2)	Map Sheet (3)	UTM Coordinates	Year Estab- lished	Elevation Gage Zero m.ü.A.	Drainage Area Km²	Maximum(HH	
									cm	Da
TRAUN RIVER BASIN										
332	OBERTRAUN	TRAUN	130.9	N-48	VN0368	1909	526.22	334	260	20/1
338	STEEG	TRAUN	117.7	N-48	UN9674	1900	505.63	646	375	7/9/
347	STROBL	ISCHL	116	N-48	UN8006	1900	536.97	125	240	7/9/
349	ISCHL (KREUZSTEIN)	TRAUN	102.8	N-48	UN9786	1900	458.15	1004	724	7/9/
350	EBENSEE	TRAUN	87.0	N-48	VN0796	1895	423.50	1258	569	1899
358	GMUNDEN (KARLSBRUECKE)	TRAUN	71.9	N-48	VP1008	1895	416.95	1424	510	1899
359	ROITHAM	TRAUN	57.4	N-49	VP1221	1914	363.26	1492	320	4/2/
371	AU AM MONDSEE	SEE-ACHE	57.5	N-48	UN8496	1928	477.03	248	196	11/4
377	KAMMER	AGER	35.6	N-48	UP9511	1895	468.57	464	151	1899
385	SCHLACHHAM	AGER	20.8	N-48	VP0117	1900	412.05	954	370	5/7/
391	LAMBACH	TRAUN	46.6	N-49	VP1627	1851	342.48	2774	731	1899
399	WELS	TRAUN	30.5	N-49	VP2734	1851	304.73	3647	1065	1899
404	EBELSBERG	TRAUN	4.7	N-49	VP5044	1850	251.88	4255	653	1899

See Notes on page 1

	Gage Height (4)				Discharge (4)					
HHW)	Mean Annual (MW)		Minimum (NNW)		Maximum (HHQ)		Mean Annual (MQ)		Minimum (NNQ)	
Date	cm	Period	cm	Date	m3/sec	Date	m3/sec	Period	m3/sec	Date
/10/41	148	1931-40	74	25/2/13	(170)	1941	19.5	1931-40	2.7	1913
/9/20	127	1940-44	69	4/2/24	(600)	1920	34.8	1940-44	7.2	1924
/9/20	(60)	*	25	16/10/47	266	1899	5.1	1926-32	(20)	1911
/9/20	121	1940-44	26	26/11/18	1210	1920	54.1	1940-44	8.5	1918
899	174	1938-47	70	6/3/17	1515	1899	74.7	1938-47	(11)	1917
899	179	1940-44	102	27/9/03	1110	1899	77.0	1940-44	(10)	1903
/2/23	98	1938-47	12	26/12/20	(1150)	1923	77.6	1938-47	(10)	1920
/4/44	54	1938-47	19	6/11/47	93.6	1947	10.5	1938-47	0.6	1947
899	41	1938-47	-6	10/11/47	191	1899	18.1	1938-47	1.7	1947
/7/18	101	1938-47	43	2/11/47	(440)	1918	33.0	1938-47	5.0	1947
899	86	1940-44	-14	31/10/47	1500	1899	108	1940-44	*	*
899	278	1938-47	157	1949	1900	1899	132	1938-47	27.0	1949
899	214	1940-44	20	3/11/47	2120	1899	138	1940-44	(30)	1947

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TABLE 4

SUMMARY OF GAGE DATA

Gage No. (1)	Gage Name	River	River Km (2)	Map Sheet (3)	UTM Coordinates	Year Estab-lished	Elevation Gage Zero m.ü.A.	Drainage Area Km^2	Maximum(HH	
									cm	Dat
ENNS RIVER BASIN										
411	RADSTADT	ENNS	230.5	N-48	UN8349	1895	823.15	187	445	18/12
418	SCHLADMING	ENNS	213.1	N-48	VN0049	1941	730.51	645	285	1/9/4
419	AICH-ASSACH	ENNS	201.0	N-48	VN1052	1861	688.80	803	365	1899
426	NEUHAUS	ENNS	174.2	N-48	VN3163	1861	639.62	1685	430	9/9/2
431	LIEZEN (ROETHELBRUECKE)	ENNS	159.9	N-48	VN4367	1857	626.95	2113	685	7/9/2
439	WENG	ENNS	[illegible]	0-48	VN6371	1874	609.95	2673	683	1899
458	GROSSRIEFLING	ENNS	106.7	0-48	VN7879	1877	435.20	4021	854	1899
462	KLEINRIEFLING	ENNS	80.5	0-48	VN7396	1895	376.47	4394	620	9/7/0
466	STEYR (NEUBRUECKE)	ENNS	31.8	0-48	VQ5720	1908	284.33	4996	600	6/7/1
467	STEYR (SCHREIBPEGEL)	ENNS	31.2	0-49	VQ5721	1851	283.99	4996	820	1899
482	ENNS	ENNS	3.9	0-49	VQ6141	1851	243.06	6082	710	1899

See Notes on page 1

Gage Height(4)					Discharge(4)					
HHW)	Mean Annual (MW)		Minimum (NNW)		Maximum (HH...)		Mean Annual (MQ)		Minimum (NN...)	
Date	cm	Period	cm	Date	m^3/sec	Date	m^3/sec	Period	m^3/sec	Date
/12/02	139	1929-33	100	24/12/22	(150)	*	5.5	'98-1940	*	*
9/41	138	1940-44	92	13/2/47	*	*	15	1940-1944	*	*
99	167	1909-13 1929-33	113	7/3/08	*	*	25.9	'98-1940	*	*
9/20	197	do	131	4/2/34	*	**	51.7	'98-1940	*	*
9/20	292	do	145	1893	*	*	64.0	'98-1940	*	*
99	307	do	221	8/3/29	(840)	1899	66.0	'98-1940	22.9	1929
99	218	do	120	1882	*	*	143	'98-1940	*	*
7/03	128	do	28	9/2/31	(1800)	*	158	'98-1940	*	*
7/14	158	do	38	28/12/48	*	*	177	'98-1940	*	*
99	149	do	37	1894	3200	*	177	'98-1940	40	1947
99	226	do	66	1851	(3200)	*	219	'98-1940	*	*

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TABLE 5

SUMMARY OF MAJOR HYDRAULIC STR

No. (1)	Name of Dam	Reservoir Name	River	River Km	Map Sheet (2)	UTM Coordinates	Type	Drainage Area Km²
	INN RIVER							
R-1	SILSER	SILSERSEE	INN	512.0	4 (6)	NS5849	Movable Weir	46
R-2	SILVAPLANER	SILVAPLANERSEE	INN	507.0	4 (6)	NS6245	Movable Weir	138
R-3	ST. MORITZ	ST. MORITZSEE	INN	501.0	4 (6)	NS6550	Movable Weir	172
R-4	ROSANNA	-	ROSANNA	7.0	M48	PT1220	Roller Weir	233
R-5	TRISANNA	-	TRISANNA	6.0	M48	PT1319	Movable Weir	363
	ISAR RIVER							
R-6	-	ACHEN SEE	ACHEN SEE	-	M48	QT0756	Power conduit	25 m³/s
	INN RIVER							
R-7	GERLOS (GMUEND)	GERLOS (GMUEND)	ZILLER/GERLOS	-	M48	QT2733	Concrete arch dam	-
R-8	KIRCHBICHEL	-	INN	232.3	M48	TN7466	Movable Weir	9313
R-9	WASSERBURG	-	INN	159.9	M49	TP9427	Movable Weir	11933
R-10	TEUFELSBRUECK	-	INN	147.2	M49	TP9733	Movable Weir	12060
R-11	GARS	-	INN	137.5	M49	TP9970	Movable Weir	12210
R-12	TOEGING (JETTENBACH)	-	INN	128.0	N49	UP0640	Movable Weir	12250
R-13	NEUOETTING	-	INN	91.1	N49	UP2847	Movable Weir	13150
R-14	BRAUNAU (SIMBACH)	-	INN	61.1	N49	UP5448	Movable Weir	22700
R-15	ERING	-	INN	48.0	N49	UP6451	Movable Weir	23390
R-16	OBERNBERG (EGGLFING)	-	INN	35.3	N49	UP7654	Movable Weir	23740
R-17	SCHAERDING	-	INN	17.7	N49	UP8468	Movable Weir	24360
R-18	PASSAU	-	INN	4.2	N49	UP8781	Movable Weir	26070
R-19	ALTENMARKT	-	ALZ	4.5	N49	UP1721	Weir	-

TRUCTURES

Capacity $m^3 10^6$	Height m	Length m	Width (Base) m	Construction Date (3)	Source Reference No. (4)	Exhibit Reference No. (5)
2.2	1.5	-	-	1947	24	A-06a (1)
2.2	1.0	-	-	1947	24	A-06a (2)
0.7	1.0	-	-	1932	24	A-06a (3)
-	1.8	18	-	--	25, 26, 27	A-07a (1)
-	1.1	14	-	--	25, 26, 27	A-07a (1)
/s power plant capacity				--	25, 26, 28, 35, 70	A-07a (5)
0.8	37	88	8	1945	24, 26, 28, 31-34	A-07a (4)(c)
(3.0)[7]	6	150	-		6, 25, 26, 28, 33, 35	A-07a (6)
(26.0)[7]	10	250	-	1935-38	28, 38, 41, 46	A-08a (2)
(8.2)[7]	10	160	-	1935-38	28, 38, 41, 46	A-08a (3)
(6.4)[7]	10	180	-	1935-38	28, 38, 41, 46	A-08a (4)
(4.2)[7]	9	122	-	1919-24	28, 37, 38, 41, 46, 47	A-08a (5)
(1.6)[7]	9	150	-	1949-53	28, 38, 41	A-08a (6)
(29.0)[7]	13.5	320	-	1953	26, 38-41, 46, 72	A-09c (1)
(52.0)[7]	12	300	-	1939-42	26, 28, 38, 41, 46	A-09b (1)
(54.0)[7]	13.5	260	-	1941-44	25, 26, 28, 38, 41, 46, 49	A-09b (2)
-	-	-	-	Planned	26, 38, 41, 49	A-09d (1)
-	-	-	-	Planned	26, 38, 41, 49	A- [illegible] (2)
-	-	-	-	1909-11	36, 37, 50, 51, 52	A-10b

NOTES:

(1) Serial Number - see General Map, Plate 1
(2) AMS Series M508 - Scale: 1:250,000
(3) U/C - under construction
(4) Reference Nos. listed in Bibliography
(5) Paragraph Reference Nos. in Exhibits A, B, C or D.
(6) AMS Series M591- Scale: 1:250,000
(7) Storage values in parenthesis are estimated
(8) Two dams on same reservoir

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WASHINGTON DISTRICT, CORPS OF ENGINEERS
NOVEMBER 1953

TABLE 5

SUMMARY OF MAJOR HYDRAULIC STRUCTURES

No. (1)	Name of Dam	Reservoir Name	River	River Km	Map Sheet (2)	UTM Coordinates	Ty
	INN RIVER BASIN						
R-20	FROSTBERG	FROSTBERG	ALZ	40	N49	UP1823	Wei
R-21	TACHERTING	TACHERTING	ALZ	35	N49	UP2027	Movable
R-22	MARGARETHENBERG	MARGARETHANBERG	ALZ	25	N49	UP2736	Wei
	SALZACH RIVER BASIN						
R-23	TAUERNMOOS	TAUERNMOOS	STUBACH/ TAUERNMOOSBACH	–	N48	UN2125	Gravity
R-24	WEISS (NORTH & EAST)	WEISS SEE (8)	WEISS SEE	–	N48	UN1923	Gravity
R-25	DROSSEN (HOHENBURG EAST)	MOOSERBODEN (8)	KAPRUNER ACHE	17	N48	UN2727	Gravity
R-26	MOOSER (HOHENBURG WEST)	MOOSERBODEN (8)	KAPRUNER ACHE	15	N48	UN2727	Gravity
R-27	LIMBERG	WASSERFALLBODEN	KAPRUNER ACHE	11.0	N48	UN2730	Concret Dam
	DRAVA (DRAU) RIVER BASIN						
R-28	MOELL	MARGARITZE (8)	MOELL	–	N48	UN3415	Arch Gr Dams
	SALZACH RIVER BASIN						
R-29	BOCKHART	BOCKHARTSEE	GASTEINER ACHE	–	N48	UN5-1-	Gravity
R-30	HALLEIN	**	SALZACH	82.9	N48	UN5783	Movable
R-31	STRUBKLAMM	STRUBKLAMM	*STRUBBACH	–	N48	UN6693	Gravity
R-32	WIESTAL	WIESTAL	ALMBACH	–	N48	UN6289	Gravity
R-33	REICHENHALL	SAALACH SEE	SAALACH	20.7	N48	UN4087	Movable
R-34	FREILASSING	SAALACH ROTT	SAALACH	2.5	N48	UP4900	Submers

ES (CONTINUED)

Type	Drainage Area Km^2	Res(7) Capacity $m^3 10^6$	Height m	Length m	Width (Base) m	Construction Date (3)	Source Reference No. (4)	Exhibit Reference No. (5)
Weir	-	-	-	-	-	1909-11	36-38, 50-52	A-09c
ble Weir	-	-	-	-	-	1916-20	36-38, 50-52	A-09d
Weir	-	-	-	84	-	1919-23	36-38, 50-52	A-09e
ity Dam	-	21.5	28	190	19.5	1929	6, 24-26, 28, 34, 42-45	B-03a(2)
ity Dam(8)	-	15.7	34	235	15.7	U/C-1951	6, 24	B-03a(2)(f)
ity Dam	-	86 (8)	115	350	-	U/C-1952	6, 24-26, 28, 32, 57-61	B-03b(3)(d)
ity Dam	-	86 (8)	110	500	-	1953	6, 24-26, 28, 32, 57-61	B-03b(3)(d)
rete Arch	-	83.6	120	370	-	1951	6, 24-26, 28, 32, 34, 45, 56-64, 87	B-03b(2)
Gravity	-	3.0 (8)	-	16.0 m^3/s pumping capacity to MOOSERBODEN Res.			24, 32, 56-61	B-03b(3)(b)
ity Dam	-	0.7	6	40	-	1912	24	B-03e(2)
ble Weir	3687	-	10	97	-	1928	6, 25, 88	---
ity Dam	-	2.5	36.5	86	-	1925-32	24-26, 34, 65	B-03h(3)
ity Dam	-	7.5	35	69	-	1910-12	24-26, 34, 65	B-03h(2)
ble Weir	-	3.5	10	77	-	1927-30	24, 38, 66-69	B-05c
ersible	-	-	[illegible].5	80	-	U/C	38, 66-6[illegible]	B-05(b)

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WASHINGTON DISTRICT, CORPS OF ENGINEERS
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TABLE 5

SUMMARY OF MAJOR HYDRAULIC STRUCTURES (CONTIN

No. (1)	Name of Dam	Reservoir Name	River	River Km	Map Sheet (2)	UTM Coordinates	Type	Dr
	TRAUN RIVER BASIN							
R-35	TOPLITZSEEKLAUSE	TOPLITZSEE	TRAUN	153.10	N48	VN1976	Weir	
R-36	GRUNDLSEEKLAUSE	GRUNDLSEE	TRAUN	145.87	N48	VN1275	Weir	
R-37	ALTAUSEEKLAUSE	ALTAUSEE	ALTAUSSEER TRAUN	4.56	N48	VN0877	Weir	
R-38	GOSAU	VORDERER GOSAUSEE	GOSAU BACH	-	N48	UN8765	Earth	
R-39	SEEKLAUS STEEG	HALLSTAETTERSEE	TRAUN	118.04	N48	UN9774	Gated Weir	
R-40	SCHWARZENSEE	SCHWARZENSEE	ISCHL	-	N48	UN8890	Earth Dam	
R-41	SEEKLAUS STROBL	WOLFGANGSEE	ISCHL	12.5	N48	UN8686	Weir	
R-42	OFFENSEE	OFFENSEE	TRAUN WEISSENBACH	-	N48	VN1291	Weir	
R-43	SEEKLAUSE GMUNDEN	TRAUNSEE	TRAUN	73.15	N48	VP1008	Weir & Lock	
R-44	REINDL-RIEDLWEHR	MONDSEE	SEEACHE	59.11	N48	UN8396	Weir	
R-45	RAUDASCHWEHR	ATTERSEE	AGER	33.71	N48	UP9511	Weir	
	ENNS RIVER BASIN							
R-46	SALZA	GRIMMING	SALZABACH	6.3	N48	VM6120	Concrete Arch Dam	
R-47	GROSSRAMING	-	ENNS	64.40	O48	VP6305	Movable Weir	
R-48	TERNBERG	-	ENNS	47.90	O48	VP5210	Movable Weir	
R-49	ROSENAU	-	ENNS	40.20	O48	VP5316	Movable Weir	
R-50	LAHRNDORF	-	ENNS	36.7	O49	VP5527	Movable Weir	
R-51	STANING	-	ENNS	20.00	O49	VP6028	Movable Weir	
R-52	MUEHLRADING	-	ENNS	13.80	O49	VP6131	Movable Weir	

TINUED)

Drainage Area Km²	Res (7) Capacity m³10⁶	Height m	Length m	Width (Base) m	Construction Date (3)	Source Reference No. (4)	Exhibit Reference No. (5)
-	34	-	-	-	-	6, 7, 12	D-05b
125	137.5	-	-	-	913	6, 7, 12	D-05c
54.5	72.4	-	-	-	-	6, 7, 12	D-05d
-	24.3	21	73	-	1913	6, 7, 12, 24, 86	-
641.6	556.7	-	102	-	-	6, 7, 12	D-05f
-	3.2	-	-	-	1908	12, 24, 86	-
122.5	619.2	-	-	-	1913	12, 24, 86	D-05e
-	0.9	-	-	-	1908	12, 24, 86	-
1418	2302	-	357	-	-	6, 7, 12	D-05g
246.5	-	-	-	-	-	6, 12	-
461.7	-	-	-	-	-	6, 12	-
150	10.5	53	120	13	1949	24, 34, 76, 77	D-06b
4644	16.0	25	-	-	1951	6, 8, 25, 26, 28, 56, 78-80, 89	D-07b
4903	5.1	17.5	-	-	1950	6, 8, 25, 26, 28, 56	D-07c
-	-	-	-	-	U/C	6, 8, 26, 28, 56	D-07a(3)
-	-	-	-	-	U/C	8, 89	D-07a(4)
6004	10	12.8	-	-	1951	6, 8, 25, 26, 28, 56, 80, 82, 83	D-07d
6004	5.0	9	170	-	1952	6, 8, 25, 26, 28, 56, 80, 84, 85	D-07e

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WASHINGTON DISTRICT, CORPS OF ENGINEERS
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SUMMARY OF ARTIFICIAL F

Flood No.	a. River Basin b. Dam or Lake c. Type of Outflow	Location (1) No.	Location (1) Name	Stream	River Km	[illegible]	Discharge (m^3/sec) Initial	Increase	Cre
I-1	a. INN	R8	KIRCHBICHEL WEIR (5)	INN	232	495.3	300	1525	18
	b. KIRCHBICHEL &	G2	ROSENHEIM	"	184	442.4	300	240	5
	Group A (Note 4)	R9	WASSERBURG WEIR	"	160	429.5	300	3400	37
	c. Open all gates	G3	WASSERBURG FERRY	"	157	426.2	300	3400	37
	of KIRCHBICHEL	R10	TEUFELSBRUCK WEIR	"	147	418.8	350	3200	35
	at Hr. 0, of	R11	GARS WEIR	"	137	410.0	350	3400	37
	Group A at	R12	JETTENBACH WEIR (5)	"	128	401.5	350	3130	34
	Hr. 3.5	R13	NEUOETTING WEIR	"	91	366.4	350	3350	37
	(Group B open	R14	BRAUNAU WEIR	"	61	Weir open or destroyed & pool			
	& empty)	282	BRAUNAU GAGE	"	58	338.3	700	1360	20
		R15	ERING WEIR	"	48	Weir open or destroyed & pool			
		R16	EGGLFING WEIR	"	35	Weir open or destroyed & pool			
		297	SCHARDING GAGE	"	16	303.1	700	1350	20
		G5	WERNSTEIN GAGE	"	8	298.0	700	1310	20
I-2	a. INN		All Stations above BRAUNAU WEIR same as Flood No. I-1						
	b. KIRCHBICHEL &	R14	BRAUNAU WEIR	INN	61	344.7	700	8000	87
	Groups A & B (Note 4)	282	BRAUNAU Gage	"	58	341.7	700	8000	87
	c. Open all gates of	R15	ERING WEIR	"	48	333.2	700	6600	73
	KIRCHBICHEL at Hr. 0,	R16	EGGLFING WEIR (5)	"	35	322.5	700	7700	84
	Group A at Hr. 3.5,	297	SCHARDING GAGE	"	16	311.5	700	6950	76
	of Group B at Hr. 9	G5	WERNSTEIN GAGE	"	8	302.9	700	5050	57
I-3	a. INN		All Stations above SALZACH River junction (Km 68) same as Flood I-1						
	b. KIRCHBICHEL,	282	BRAUNAU GAGE	INN	58	339.6	700	3000	37
	Group A (Note 4)	R15	ERING WEIR	"	48	Weir open or destroyed & pool			
	& LIMBERG (Flood S-1)	R16	EGGLFING WEIR	"	35	Weir open or destroyed & pool			
	c. Breach LIMBERG	297	SCHARDING GAGE	"	16	304.3	700	2440	31
	2 hrs. before opening	G5	WERNSTEIN GAGE	"	8	299.2	700	2280	29
	all gates of KIRCHBICHEL								
	at Hr. 0, of Group A								
	at Hr. 3.5, so peaks								
	coincide (Group B open								
	& empty)								
I-4	a. INN		All Stations above SALZACH River junction (Km 68) same as Flood I-2						
	b. KIRCHBICHEL,	282	BRAUNAU GAGE	"	58	341.7	700	8000	87
	Groups A & B (Note 4)	R15	ERING WEIR	"	48	333.2	700	6600	73
	& LIMBERG (Flood S-1)	R16	EGGLFING WEIR	"	35	332.2	700	7300	80
	c. Breach LIMBERG	297	SCHARDING GAGE	"	16	311.5	700	7100	78
	2 hrs. before opening	G5	WERNSTEIN GAGE	"	8	302.9	700	5450	61
	all gates of KIRCHBICHEL								
	at Hr. 0, Group A at								
	Hr. 3.5, and Group B								
	at Hr. 9								

NOTES: See page 3

FLOOD EFFECTS

[illegible]) [illegible]rest	River Depth (m) Initial	Increase	Crest	Crest(2) Overflow Height(m)	River Width(m) Initial	Crest	Mean Surface Velocity(m/sec)(3) Initial	Crest	Time (Hr.) Start of Rise	Crest	Duration (Hours) Above Top of Bank	0.5m above Base Flow
1825	3.5	6.0	9.5	Bankfull	60	250	2.0	4.5	0 (8)	0	0	1
540	1.0	1.0	2.0	In Banks	100	300	2.0	2.5	1	4	0	2
3700	-	-	-	Bankfull	-	-	-	-	3.5	3.5	-	-
3700	1.0	5.0	6.0	0.5	60	450	1.0	4.5	3.5	3.5	2	5
3550	-	-	-	Bankfull	-	-	-	-	3.5	3.5	-	-
3750	-	-	-	Bankfull	-	-	-	-	3.5	3.5	-	-
3480	2.5	5.0	7.5	Bankfull	120	200	1.0	4.0	3.5	4	0	6
3700	-	-	-	-	-	-	-	-	-	-	-	-
ol empty		-	-	-	-	-	-	-	-	-	-	-
2060	3.0	2.5	5.5(7)	In Banks(7)	150	280(7)	2.5	5.0	8	13	0	9
ol empty		-	-	-	-	-	-	-	-	-	-	-
ol empty		-	-	-	-	-	-	-	-	-	-	-
2050	2.0	1.5	3.5(7)	In Banks(7)	150	300(7)	3.5	4.5	12	19	0	11
2010	1.5	2.5	4.0	In Banks	200	400	2.5	3.5	14	21	0	7
8200	-	-	-	Bankfull	-	-	-	-	-	-	-	-
[illegible]700	3.0	6.0	9.0(7)	1.5 (7)	150	1000(7)	2.5	3.5	9 (8)	9	1	8
7300	-	-	-	Bankfull	-	-	-	-	9	9	-	-
[illegible]400	4.0	7.5	11.5	Bankfull	150	500	1.5	6.5	9	9	0	11
7650	2.0	10.0	12.0(7)	1.5 (7)	150	1000(7)	3.5	6.5	10	12	4	13
57[illegible]	1.5	7.5	9.0	3.5	200	400	2.5	5.0	10	16	10	14
3700	3.0	4.0	7.0(7)	Bankfull	150	400(7)	2.5	[illegible].5	8 (8)	13	0	11
ol empty		-	-	-	-	-	-	-	-	-	-	-
ol empty		-	-	-	-	-	-	-	-	-	-	-
6140	2.0	2.5	4.5(7)	In Banks(7)	150	300(7)	3.5	4.5	12	19	0	11
2980	1.5	3.5	5.0	0.5	200	400	2.5	4.0	14	23	4	10
8700	3.0	6.0	9.0(7)	1.5 (7)	150	1000(7)	2.5	3.5	9 (8)	9	1	10
7300	-	-	-	Bankfull	-	-	-	-	9	9	-	-
8000	4.0	7.5	11.5	Bankfull	150	500	1.5	6.5	9	9	0	14
7800	2.0	9.5	11.5(7)	1.5 (7)	150	1000(7)	3.5	6.5	9	12	4	16
6150	1.5	7.5	9.0	3.5	200	400	2.5	5.0	10	16	10	18

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WASHINGTON DISTRICT, CORPS OF ENGINEERS
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Flood No.	a. River Basin b. Dam or Lake c. Type of Outflow	Location (1) No.	Location (1) Name	Stream	River Km	Crest Elev. (m.ü.A.)	Discharge ($m^3/$ Initial	Increase
S-1	a. SALZACH (KAPRUNER ACHE)	R27	LIMBERG DAM	KAPRUNER	177	–	0	8500
	b. LIMBERG	206	BRUCK I. P.	SALZACH	161	754.5	40	2400
	c. Parabolic breach,	232	ST. JOHANN I. P.	"	127	566.0	100	2050
	70 m wide & 25 m deep	249	HALLEIN GAGE	"	80	442.3	150	2000
		281	ACH GAGE	"	11	358.0	250	1480
			SALZACH-INN RIVER	JUNCTION	(6)			
		R15	ERING WEIR	INN	48	Weir open or destroyed & po		
		R16	EGGLFING WEIR	"	35	Weir open or destroyed & po		
		G5	WERNSTEIN GAGE	"	8	297.5	700	1060
T-1	a. TRAUN R.	358	GMUNDEN	TRAUN	72	420.5	75	165
	b. TRAUN SEE	359	ROITHAM	"	57	365.5	80	155
	c. Breach special	391	LAMBACH	"	47	344.0	110	155
	dam at normal	399	WELS	"	31	308.0	130	155
	lake level	404	EBELSBERG	"	5	255.0	140	150
T-2	a. TRAUN R.	358	GMUNDEN	TRAUN	72	421.0	75	635
	b. TRAUN SEE	359	ROITHAM	"	57	366.5	80	600
	c. Breach special	391	LAMBACH	"	47	346.0	110	599
	dam at 2 m	399	WELS	"	31	309.5	130	590
	above normal lake	404	EBELSBERG	"	5	256.5	140	575
T-3	a. TRAUN R.	347	STROBL (WOLFGANG S.)	ISCHL	116	538.8	5	80
	b. HALLSTAETTER, WOLFGANG, TRAUN, MOND & ATTER SEE	338	STEEG (HALLSTAETTER S.)	TRAUN	118	509.0	35	415
	c. Coordinated breaches at above normal lake levels (see Par. 4-02c(2).	349	ISCHL	TRAUN	103	463.5	55	465
		350	EBENSEE	"	87	427.5	75	410
		358	GMUNDEN (TRAUN S.)	"	72	421.0	75	655
		359	ROITHAM	"	57	366.5	80	695
		371	AU AM MONDSEE (MOND S.)	SEE ACHE	58(10)	479.0	20	85
		377	KAMMER (ATTER S.)	AGER	36(10)	470.5	20	260
		385	SCHLACHHAM	"	20(10)	415.0	35	260
		391	LAMBACH	TRAUN	47	347.0	110	890
		399	WELS	"	31	310.5	130	879
		404	EBELSBERG	"	5	257.0	140	865

NOTES: See page 3

[illegible] (m)	River Depth (m) Initial	Increase	Crest	Crest(2) Overflow Height (m)	River Width (m) Initial	Crest	Mean Surface Velocity (m/sec)(3) Initial	Crest	Time (Hr.) Start of Rise	Crest	Duration (Hours) Above Top of Bank	0.5m above Base Flow
3500	-	-	-	-	-	-	-	-	0	0	-	-
7440	2.0	6.0	8.0	2.0	30	1000	1.0	5.0	0(9)	1	2	4
2150	2.0	3.5	5.5	1.5	30	700	1.5	6.5	2	4	4	7
2150	1.5	7.0	8.5	0.5	90	400	2.0	4.5	5	7	2	7
1730	2.5	4.0	6.5	1.5	120	800	1.0	4.0	10	14	6	10
-	-	-	-	-	-	-	-	-	-	-	-	-
pool empty	-	-	-	-	-	-	-				-	-
pool empty	-	-	-	-	-	-	-	-	-	-	-	-
1760	1.5	2.0	3.5	In Banks	200	300	2.5	3.0	19	25	0	9
240	3.0	2.0	5.0	Bankfull	140	190	0.5	1.0	0	0	0	24
295	2.5	1.0	3.5	In Banks	50	100	1.0	1.5	3	5	0	36
265	1.5	1.0	2.5	In Banks	40	60	1.0	2.0	4	6	0	24
285	2.5	0.5	3.0	In Banks	70	80	1.5	2.5	5	8	0	18
290	2.0	1.0	3.0	In Banks	50	70	1.5	2.5	8	11	0	24
710	3.0	2.5	5.5	0.5	140	200	0.5	1.5	0	0	12	72
600	2.5	2.0	4.5	0.5	50	400	1.0	2.0	2	4	24	78
705	1.5	3.0	4.5	Bankfull	40	100	1.0	2.5	4	6	0	72
720	2.5	2.0	4.5	Bankfull	70	150	1.5	3.0	5	8	0	60
715	2.0	2.5	4.5	0.5	50	350	1.5	3.0	8	10	12	72
95	-	-	-	-	-	-	-	-	0	0	-	-
450	3.0	2.0	5.0	In Banks	60	70	1.0	2.0	0	0	0	24
520	1.5	4.0	5.5	0.5	40	100	1.5	2.5	1	2	1	84
485	3.0	2.5	5.5	Bankfull	100	200	0.5	1.5	3	6	0	48
730	3.0	2.5	5.5	0.5	140	200	0.5	1.5	6	6	24	114
715	2.5	2.0	4.5	0.5	50	400	1.0	2.0	9	10	36	120
95	-	-	-	-	-	-	-	-	9	9	-	-
280	-	-	-	-	-	-	-	-	9	9	-	-
395	1.5	2.0	3.5	Bankfull	20	30	1.0	2.0	10	10	0	210
1000	1.5	4.0	5.5	0.5	40	150	1.0	3.0	10	12	13	180
[illegible]	2.5	3.0	5.5	0.5	70	250	1.5	3.0	11	15	18	180
1605	2.0	3.0	5.0	1.0	50	700	1.5	3.0	15	20	54	180

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WASHINGTON DISTRICT, CORPS OF ENGINEERS
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Flood No.	a. River Basin b. Dam or Lake c. Type of Outflow	Location (1) No.	Location (1) Name	Stream	River Km	Crest Elev. (m.u.A.)	Discharge (Initial	Discharge (Incre
E-1	a. ENNS R.	R46	SALZA DAM	SALZABACH	6(12)	-	0	850
	b. SALZA	439	WENG	ENNS	135	616.7	50	70
	c. Parabolic Breach	462	KLEINREIFLING	ENNS	80	330.5	160	68
	70 m wide x 25 m deep	R47	GROSSRAMING WEIR	"	64	Weir destroyed & pool e		
		R48	TERNBERG WEIR	"	48	Weir destroyed & pool e		
		467	STEYR	"	31	287.5	175	66
		R51	STANING WEIR	"	20	Weir destroyed & pool e		
		R52	MUEHLRADING WEIR	"	14	Weir open or destroyed		
		482	ENNS	"	4	246.6	220	58
E-2	a. ENNS R.	R51	STANING WEIR	ENNS	20	275.7	220	333
	b. STANING	R52	MUEHLRADING WEIR	"	14	Weir open or destroyed		
	c. All gates open	482	ENNS	"	4	248.5	220	175
E-3	a. ENNS R.	R47	GROSSRAMING WEIR	ENNS	64	355.2	165	333
	b. GROSSRAMING	R48	TERNBERG WEIR	"	48	Weir destroyed & pool e		
	c. All gates open	467	STEYR	"	31	289.5	175	182
		R51	STANING WEIR	"	20	Weir destroyed & pool e		
		R52	MUEHLRADING WEIR	"	14	Weir open or destroyed		
		482	ENNS	"	4	248.3	220	161
E-4	a. ENNS R.	R47	GROSSRAMING WEIR	ENNS	64	355.2	165	33
	b. GROSSRAMING	R48	TERNBERG WEIR	"	48	322.4	170	35
	TERNBERG	467	STEYR	"	31	290.3	175	227
	STANING	R51	STANING WEIR	"	20	275.9	220	350
	MUEHLRADING	R52	MUEHLRADING WEIR	"	14	265.9	220	328
	c. All gates open at GROSSRAMING at Hr. 0 All gates open at TERNBERG at Hr. 0.5 All gates open at STANING at Hr. 1.5 All gates open at MUEHLRADING at Hr. 1.5	482	ENNS	"	4	250.2	220	292

NOTES: (1) See Table 4 for gaging station data, Table 5 for dam data, Plates 1 & 2 for map locations, corre
(2) Approx. height of crest above average top of bank in vicinity.
(3) Velocities at low stages affected by weirs. Max. surface velocity may be 50-75% greater than me
(4) Group A is WASSERBURG (R-9), TEUFELSBURG (R-10), GARS (R-11), JETTENBACH (R-12), & NEUOETTING (
(5) Tailwater below weir.
(6) SALZACH-INN junction at SALZACH Km 0, INN Km 68.
(7) Dikes along bank considered intact and limiting width of flooding; crest overflow height in ref
(8) Zero Time at opening of KIRCHBICHEL Weir (also see Note 9).
(9) Zero Time at LIMBERG Breaching (for combination with INN River Floods, LIMBERG breached 2 hrs.
(10) Km above mouth of AGER River. The AGER-TRAUN junction is at TRAUN R., Km 47.8.
(11) Overbank flooding to considerable depths, lasting from 1 to 2 hours, will occur at the junction
(12) SALZABACH-ENNS junction at SALZABACH Km 0, ENNS Km 181.9.

(Continued) CONFIDENTIAL

e (m3/sec)		River Depth (m)			Crest(2) Overflow	River Width(m)		Mean Surface Velocity(m/sec)(3)		Time (Hr.)		Duration (Hours)	
rease	Crest	Initial	Increase	Crest	Height(m)	Initial	Crest	Initial	Crest	Start of Rise	Crest	Above Top of Bank	0.5m above Base Flow
3500	8500	-	-	-	-(11)	-	-	-	-	0	0	-	-
700	780	2.0	3.5	5.5	Bankfull	50	60	1.0	3.0	6	[illegible]	0	7
685	845	4.0	2.5	6.5	In Banks	60	70	2.0	3.5	9	12	0	7
l empty													
l empty													
660	835	3.0	1.5	4.5	In Banks	90	110	0.5	2.0	12	15	0	6
l empty													
ed & pool empty													
580	800	2.5	1.0	3.5	In Banks	70	140	2.0	3.0	14	17	0	7
3330	3550	7.0	7.5	14.5	In Banks	175	210	0.5	3.5	0	0	0	2
ed & pool empty													
1750	1970	2.5	3.0	5.5	In Banks	70	150	2.0	4.5	0.5	1.5	0	2
3335	3500	7.0	7.5	14.5	In Banks	70	110	0.5	5.0	0	0	0	3
l empty													
1820	1995	3.0	4.0	7.0	In Banks	90	120	0.5	3.5	1	2	0	4
l empty													
ed & pool empty													
1610	1830	2.5	3.0	5.5	In Banks	90	130	2.0	4.5	2	3.5	0	4
3335	3500	7.0	7.5	14.5	In Banks	70	110	0.5	5.0	0	0	0	3
3530	3700	3.0	8.0	11.0	In Banks	80	110	0.5	5.0	0.5	0.5	0	4
2270	2445	3.0	5.0	8.0	In Banks	90	130	0.5	3.5	1.5	2.0	0	5
3500	3720	7.0	6.0	13.0	In Banks	175	210	0.5	3.5	1.5	1.5	0	5
3280	3500	7.0	5.0	12.0	In Banks	160	200	0.5	3.5	1.5	1.5	0	6
2920	3140	2.5	4.5	7.0	In Banks	70	160	2.0	4.5	2.0	3.0	0	6

orresponding to serial numbers.

n mean surface velocity.

C (R-13) WEIRS; Group B is BRAUNAU (R-14), ERING (R-15), & EGGLFING (R-16) WEIRS.

reference to top of dikes.

s. before KIRCHBICHEL release).

ion of the SALZBACH and ENNS Rivers above LIEZEN.

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WASHINGTON DISTRICT, CORPS OF ENGINEERS
NOVEMBER 1953

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TABLE 7
LOAD CHARACTERISTICS OF U. S. ARMY FLOATING BRIDGES
LOAD CLASS (TONS) OF FLOATING BRIDGES (by VELOCITY, by TYPE, by RELATIVE CROSSING SAFETY)

Type	Status (1952)	Relative Crossing Safety																Velocity to destroy with no Load (fps)
		Safe						Caution					Risk					
		Maximum Surface Velocity fps / m/sec						Maximum Surface Velocity fps / m/sec					Maximum Surface Velocity fps / m/sec					
		0	3	5	7	9	11	3	5	7	9	11	3	5	7	9	11	
		0	0.92	1.5	2.1	2.7	3.4	0.92	1.5	2.1	2.7	3.4	0.92	1.5	2.1	2.7	3.4	
M2 Assault Boat Bridge (Normal Construction)	Standard	8	8	6	5	-	-	8	6	5	-	-	9	7	6	-	-	10
M2 Assault Boat Bridge (Reinforced Construction)	Standard	13	13	9	7	-	-	13	11	8	-	-	14	12	9	-	-	9
Widened Steel Treadway Br.	Standard	50	50	50	40	30	15	50	50	45	35	20	55	55	50	45	30	14
50-T (Divisional Airborne)	Standard	50	45	35	30	10	-	50	40	35	15	-	55	50	45	25	-	12
M4 (Normal Construction) (15' Bay)	Standard	55	55	55	55	45	30	60	60	60	50	40	65	65	65	55	45	16
Steel Class 60 Floating Br.	Standard	60	60	60	55	50	15	65	65	60	55	30	75	75	70	65	45	-
M4 (Reinforced Construction) ([illegible]' Bay)**	Standard	95*	95*	95*	95*	70	40	100*	100*	100*	85	55	105*	105*	105*	100	70	[illegible]
M4-T6	Developmental	55	50	50	50	35	15	(No further data)										-
Aluminum Class 60 Floating Br.	Developmental	70	70	70	65	55	45	(No further data)										

*Tank data (limited by width of roadway and width of tank)
**(100% reinforced, with full Pontoons)

SOURCES:
(1) Ref [illegible]
(2) Ref [illegible]
(3) Misc data Engr. R&D Lab. Engr. Center, Ft. Belvoir

Prepared by Military Hydrology R&D Branch
Washington District, Corps of Engineers, Nov. 1952

Table [illegible]

PLATES

PLATES (Continued)

11. Artificial Flood Graphs
    a. Inn River
    b. Salzach River
    c. Traun River
    d. Enns River

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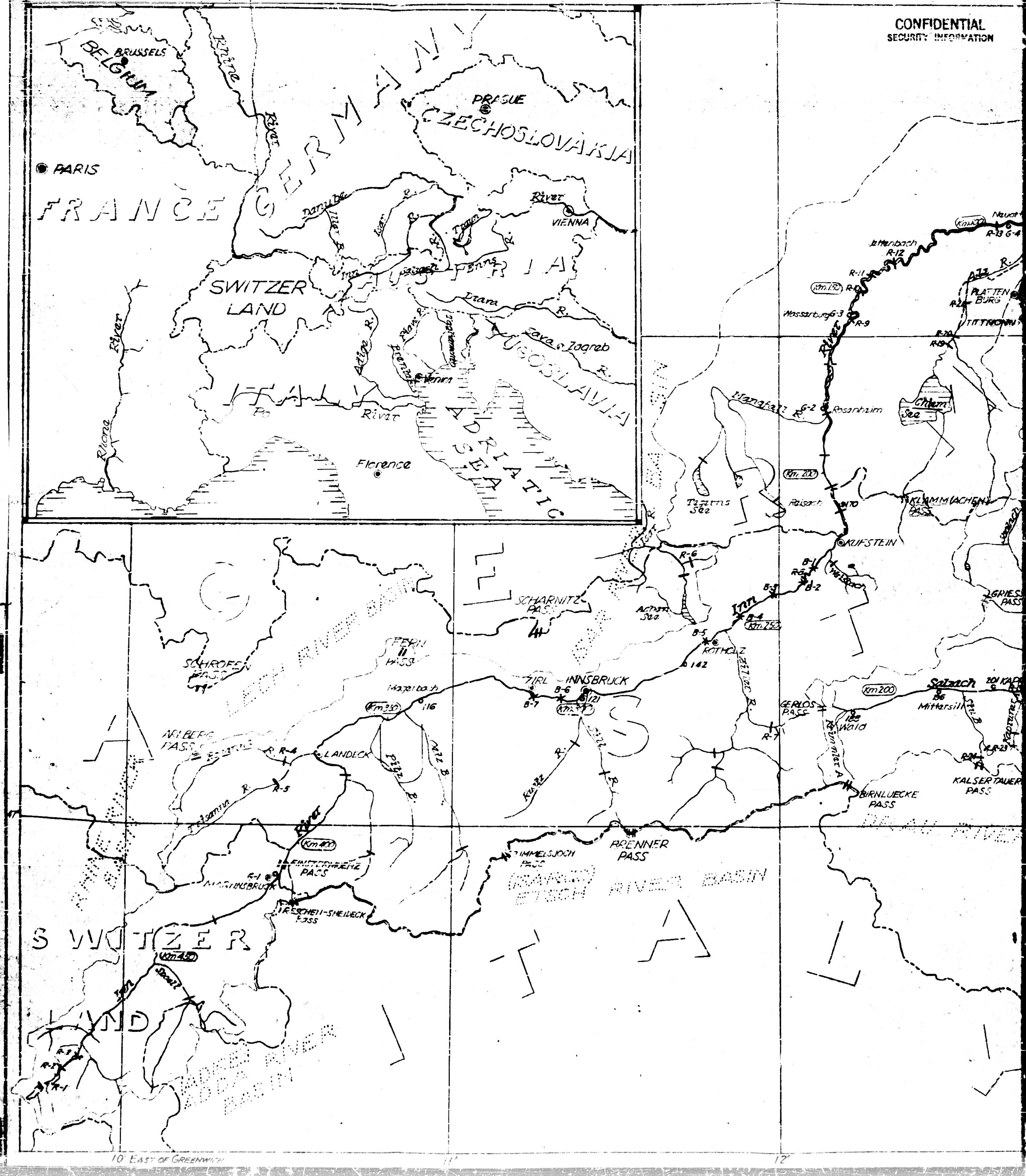
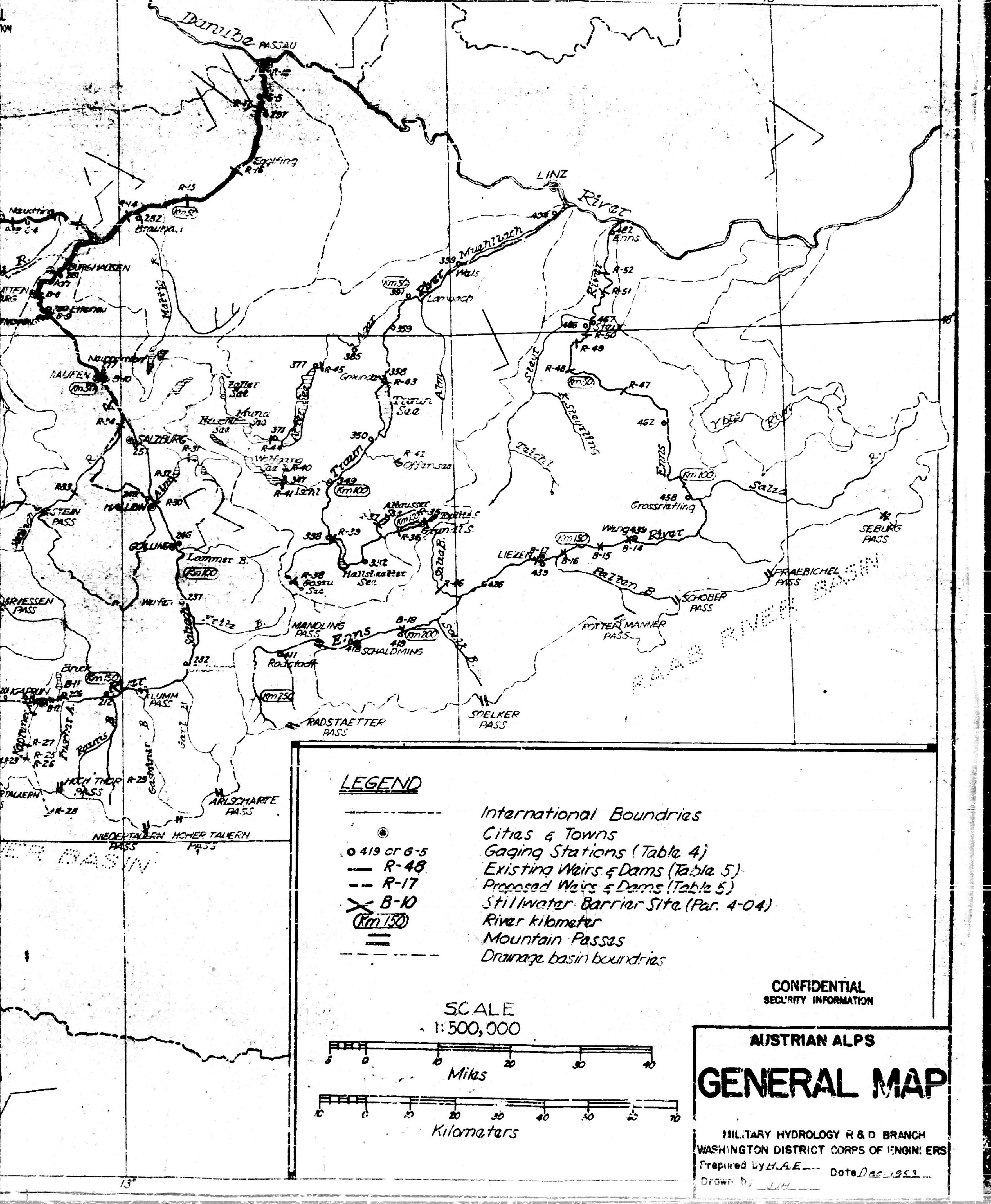
SECURITY INFORMATION





Danube
PASSAU
LINZ
River
Muehlbach
Wels
Lambach
Enns
Steyr
Ybbs River
Salza
Grossreifling
Eggling
Braunau
BURGHAUSEN
LAUFEN
SALZBURG
HALLEIN
GOLLING
Zeller See
Mond See
Wolfgang See
Attersee
Traun See
Alm
Traun
Ischl
Offensee
Altaussee
Grundl S.
Hallstaetter See
Gosau See
Lammer B.
Salzach
Teichl
Steyrling
LIEZEN
Palten B.
SCHOBER PASS
PRAEBICHEL PASS
SEBURG PASS
ROTTENMANNER PASS
MANDLING PASS
Enns
SCHLADMING
Radstadt
RADSTAETTER PASS
SOELKER PASS
ARLSCHARTE PASS
NIEDERTAUERN PASS
HOHER TAUERN PASS
HOCH THOR PASS
KLUMM PASS
GRIESSEN PASS
STEIN PASS
KAPRUN
Bruck
Werfen
Fritz B.
Gasteiner B.
RAAB RIVER BASIN
LEGEND
International Boundries
Cities & Towns
419 or G-5 Gaging Stations (Table 4)
R-48 Existing Weirs & Dams (Table 5)
R-17 Proposed Weirs & Dams (Table 5)
B-10 Stillwater Barrier Site (Par. 4-04)
Km 150 River kilometer
Mountain Passes
Drainage basin boundries
SCALE
1:500,000
5 0 10 20 30 40
Miles
10 0 10 20 30 40 50 60 70
Kilometers
CONFIDENTIAL
SECURITY INFORMATION
AUSTRIAN ALPS
GENERAL MAP
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by H.A.E. Date Dec 1953
Drawn by
13°

INN
INN

GEWÄSSERNETZ MIT PEGELSTELLEN U. NIEDERSCHLAGSBEOBACHTUNGSORTEN

STREAM NET WITH RIVER & RAINFALL GAGE LOCATIONS

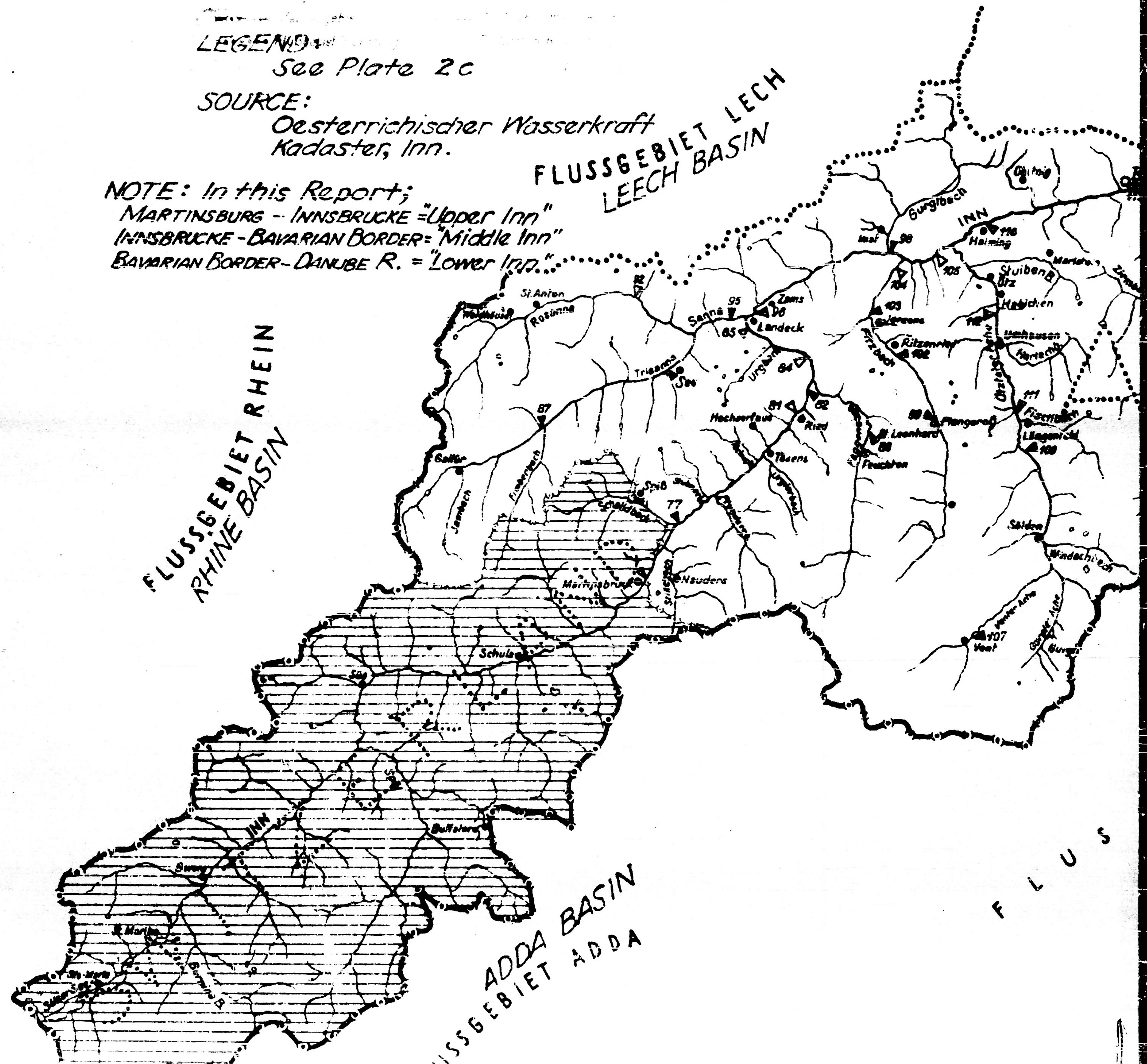
1:500 000

10 5 0 5 10 15 20 25 30 km

LEGEND:
See Plate 2c

SOURCE:
Oesterrichischer Wasserkraft
Kadaster, Inn.

NOTE: In this Report;
MARTINSBURG -- INNSBRUCKE = "Upper Inn"
INNSBRUCKE - BAVARIAN BORDER = "Middle Inn"
BAVARIAN BORDER - DANUBE R. = "Lower Inn."



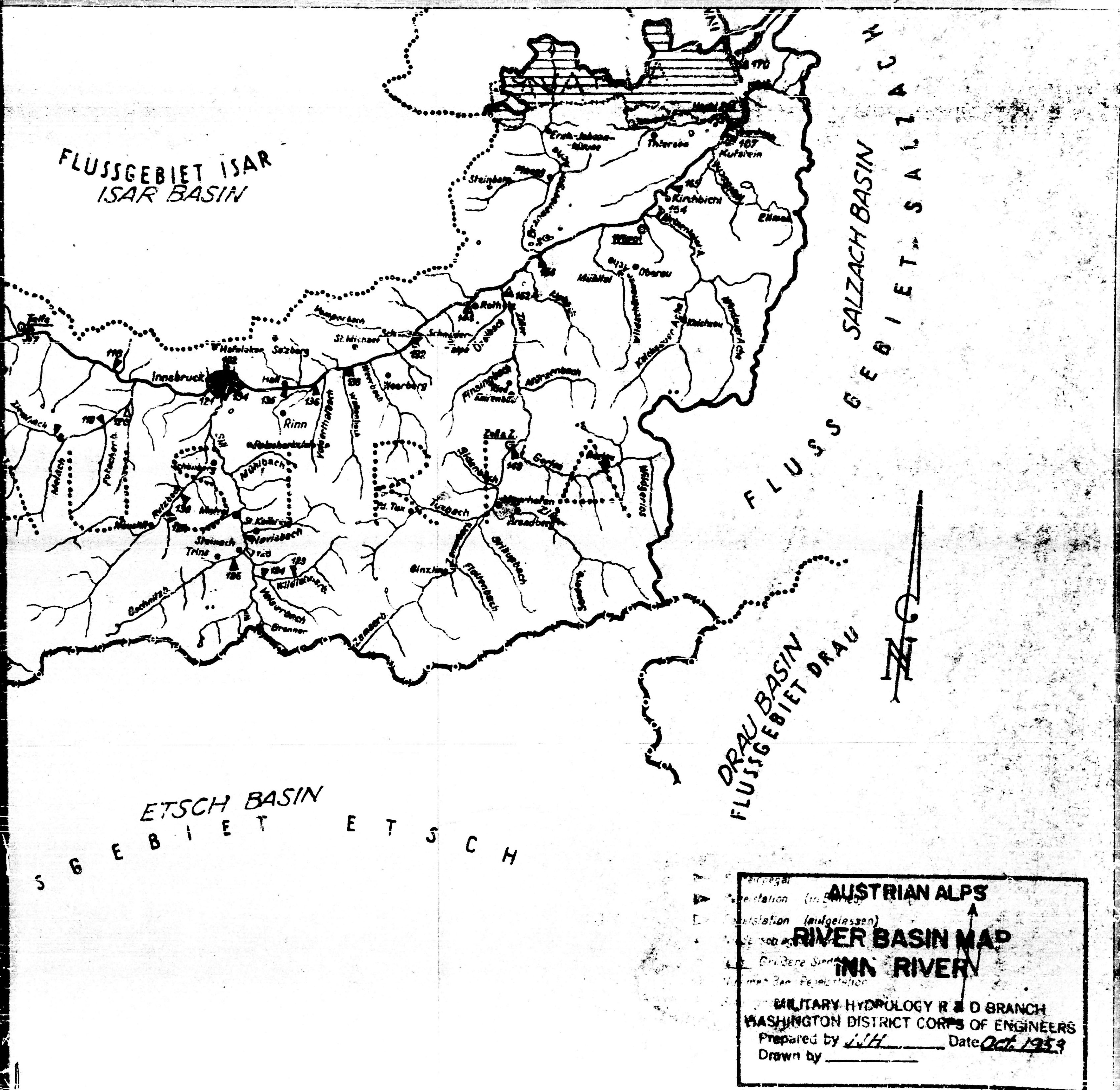
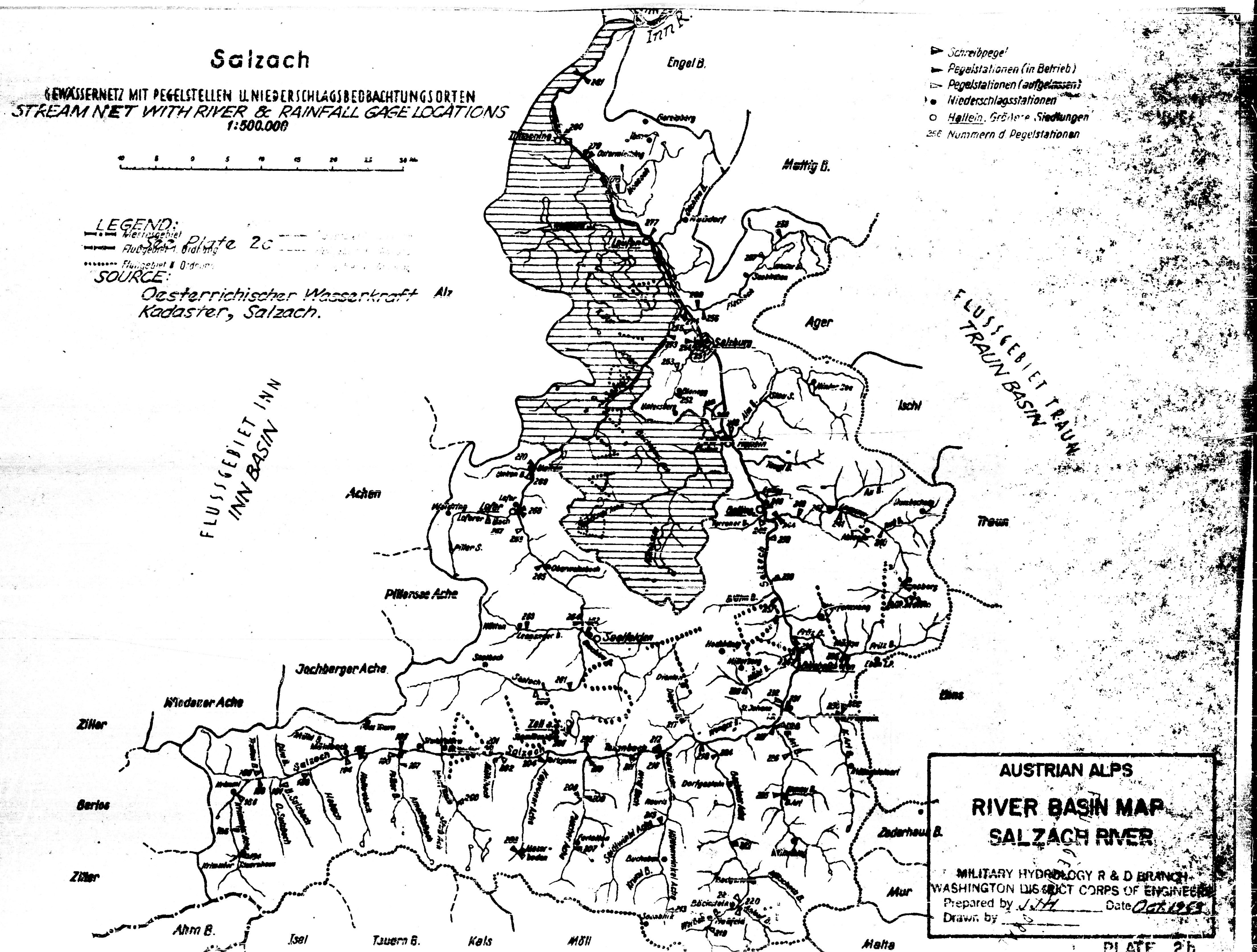

FLUSSGEBIET ISAR
ISAR BASIN
SALZACH BASIN
FLUSSGEBIET SALZACH
DRAU BASIN
FLUSSGEBIET DRAU
ETSCH BASIN
SGEBIET ETSCH
Innsbruck
Kufstein
Kirchbichl
Thiersee
Steinberg
Rinn
Hall
Salzberg
St. Michael
Schneider-alpe
Gerlos
Zell a. Z.
Mayrhofen
Tuxbach
Ziller
Finsingbach
Sill
Schönberg
Matrei
Steinach
Trins
Gschnitzb.
Navisbach
St. Kathrein
Brenner
Ginzling
Zemmbach
Floitenbach
Stillupbach
Wildgerlos
Kelchsau
Ellmau
Oberau
Mühltal
Wörgl
Rothholz
Weerberg
Mühlbach
AUSTRIAN ALPS
RIVER BASIN MAP
INN RIVER
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by
Date Oct. 1953
Drawn by

PLATE 26



Salzach
GEWÄSSERNETZ MIT PEGELSTELLEN U. NIEDERSCHLAGSBEOBACHTUNGSORTEN
STREAM NET WITH RIVER & RAINFALL GAGE LOCATIONS
1:500.000
LEGEND:
See Plate 2c
SOURCE:
Oesterrichischer Wasserkraft Kadaster, Salzach.
Schreibpegel
Pegelstationen (in Betrieb)
Pegelstationen (aufgelassen)
Niederschlagsstationen
Hallein, Grössere Siedlungen
256 Nummern d. Pegelstationen
Inn R.
Engel B.
Mattig B.
Ager
FLUSSGEBIET TRAUN
TRAUN BASIN
Ischl
Traun
Enns
Mur
Malta
FLUSSGEBIET INN
INN BASIN
Achen
Pillersee Ache
Jochberger Ache
Windauer Ache
Ziller
Berlos
Ziller
Ahm B.
Isel
Tauern B.
Kals
Möll
Zederhaus B.
Salzburg
Laufen
Lofer
Saalfelden
Zell a. S.
Salzach
AUSTRIAN ALPS
RIVER BASIN MAP
SALZACH RIVER
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by J.H. Date Oct 1953
Drawn by

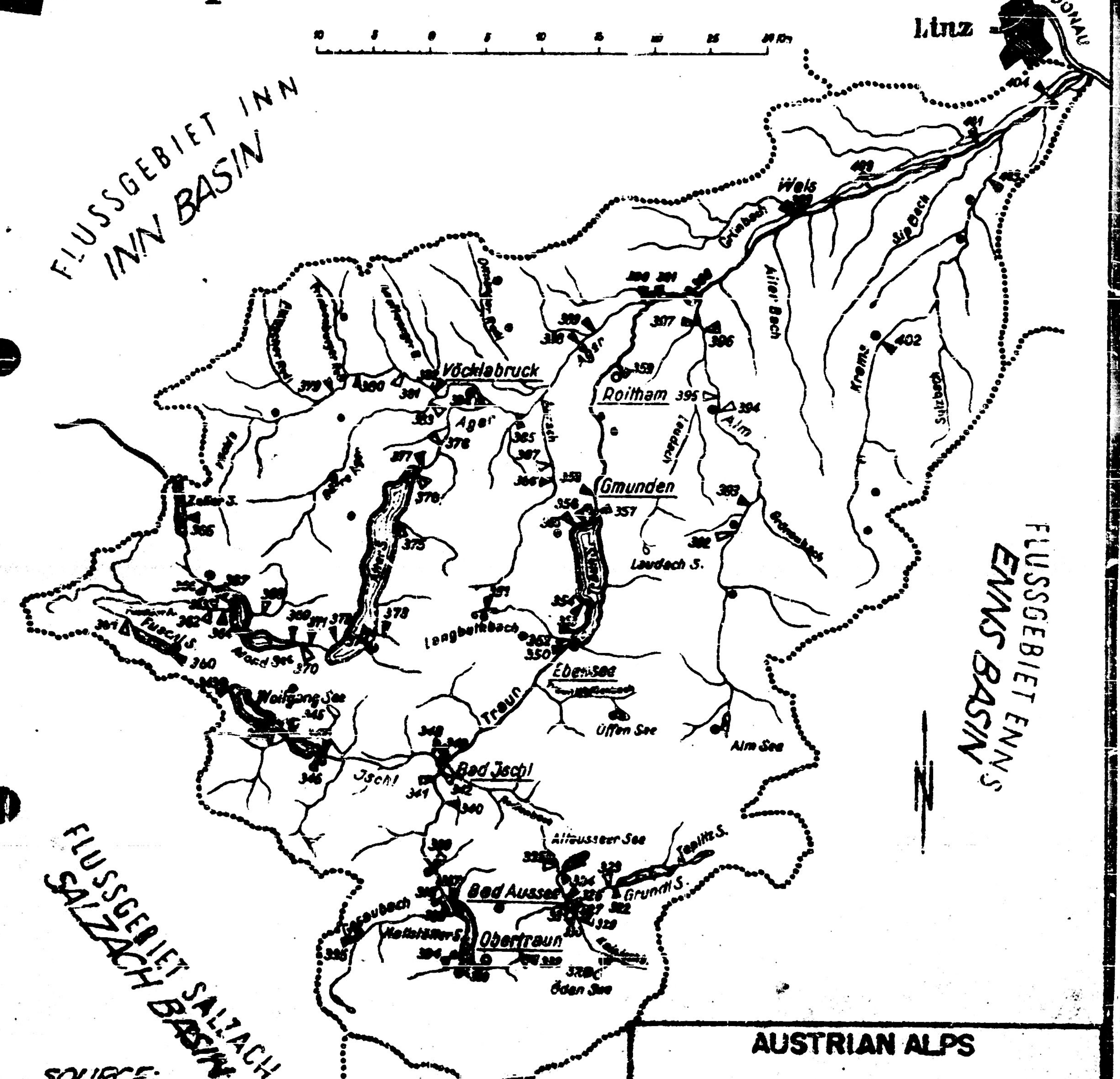
PLATE 2b

Traun

GEWÄSSERNETZ MIT PEGELSTELLEN U. NIEDERSCHLAGSBEOBACHTUNGSORTEN

STREAM NET WITH RIVER & RAINFALL GAGE LOCATIONS

1:500.000



SOURCE:
Oesterrichischer Wasserkraft Kadaster, Traun.

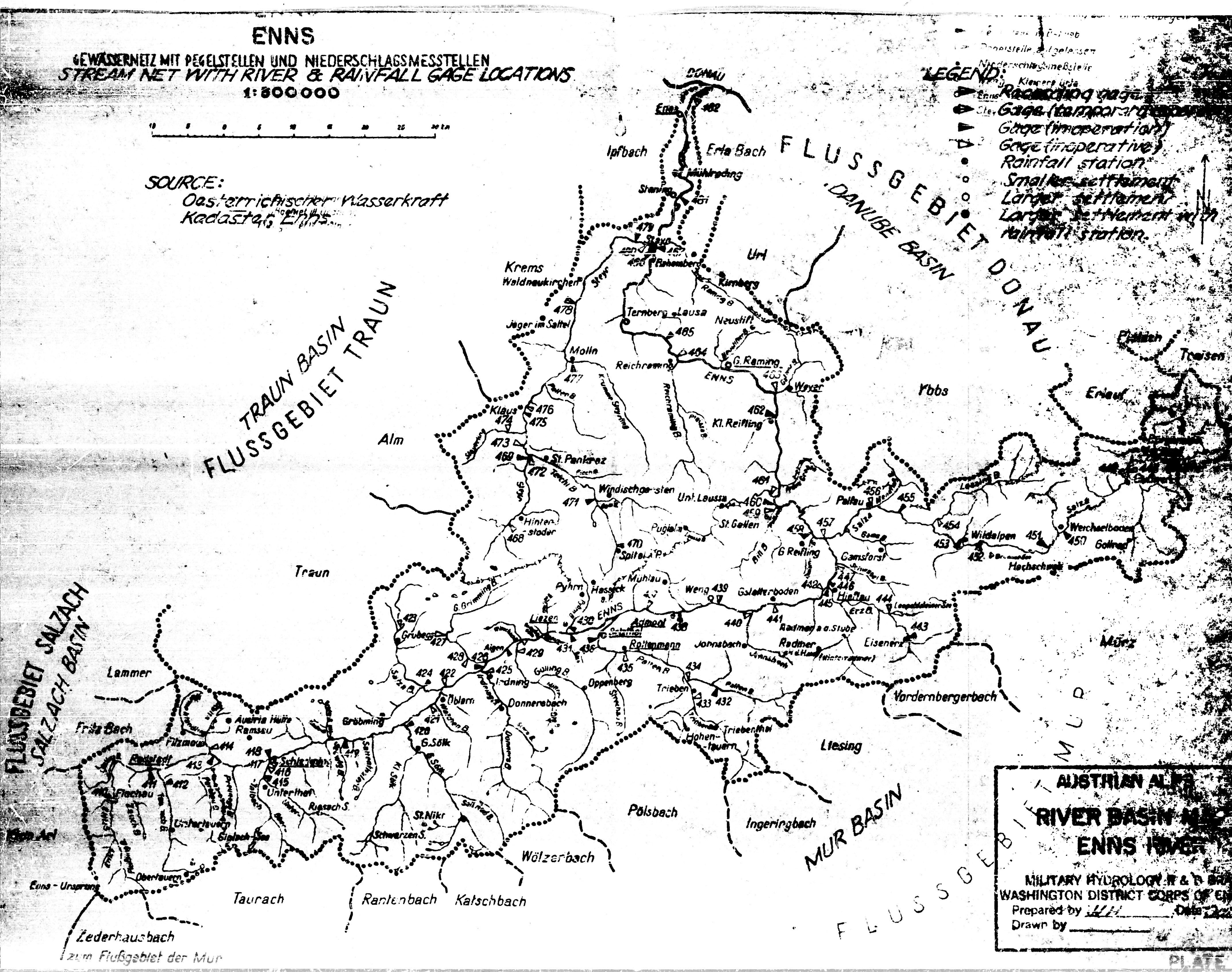
▶	Schreibpegel	▶	*Recording gage*
	Pegelstationen (in Betrieb)		*Gage (in operation)*
	Pegelstationen (aufgelassen)	▷	*Gage (inoperative)*
	Niederschlagsstationen	•	*Rainfall station*
	Gmunden: in Siedlungen	○	*Major Settlement*
111	Nummern d. Pegelstationen	111	*Gage Number*

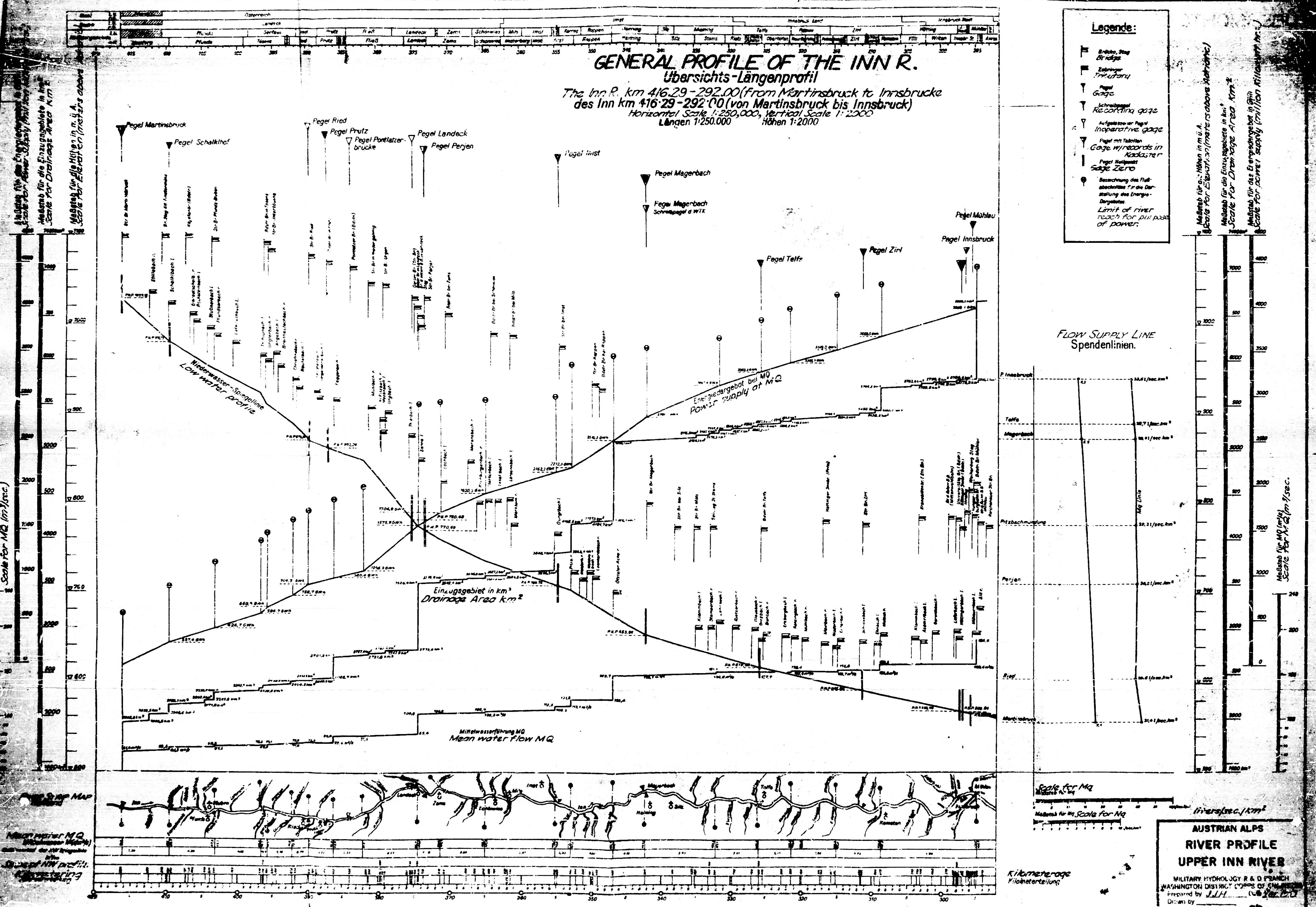
AUSTRIAN ALPS

RIVER BASIN MAP
TRAUN RIVER

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by *J.J.H.* Date *Oct 1953*
Drawn by ________

PLATE 2c


ENNS
GEWÄSSERNETZ MIT PEGELSTELLEN UND NIEDERSCHLAGSMESSTELLEN
STREAM NET WITH RIVER & RAINFALL GAGE LOCATIONS
1:500000
SOURCE:
Oesterrichischer Wasserkraft Kadaster, Enns
LEGEND:
Gage (inoperative)
Gage (inoperative)
Rainfall station
Larger settlement
FLUSSGEBIET DONAU
DANUBE BASIN
TRAUN BASIN
FLUSSGEBIET TRAUN
FLUSSGEBIET SALZACH
SALZACH BASIN
MUR BASIN
FLUSSGEBIET MUR
DONAU
Enns
Ipfbach
Erla Bach
Mühlrading
Steyr
Krems
Waldneukirchen
Jäger im Sattel
Molln
Reichraming
Ternberg
Losenstein
Neustift
G. Reming
ENNS
Weyer
Url
Ybbs
Kl. Reifling
Klaus
St. Pankraz
Windischgarsten
Hinterstoder
Alm
Traun
Unt. Laussa
St. Gallen
Palfau
Wildalpen
Weichselboden
Gollrad
Salza
Hochschwab
Erlauf
Traisen
Spital a. P.
Pyhrn
Hasseck
Mühlau
Weng
Gstatterboden
Hieflau
Gams
Gamsforst
G. Reifling
Liezen
Admont
Rottenmann
Johnsbach
Radmer
Eisenerz
Erz B.
Mürz
Grubegg
Aigen
Irdning
Donnersbach
Gulling B.
Oppenberg
Trieben
Triebenthal
Hohentauern
Liesing
Vordernbergerbach
Lammer
Fritz Bach
Filzmoos
Radstadt
Flachau
Austria Hütte
Ramsau
Gröbming
Öblarn
Schladming
Unterthal
Untertauern
Obertauern
Riesach S.
G. Sölk
St. Nikl.
Schwarzen S.
Pölsbach
Ingeringbach
Wölzerbach
Taurach
Rantenbach
Katschbach
Zederhausbach
Enns - Ursprung
zum Flußgebiet der Mur
AUSTRIAN ALPS
RIVER BASIN MAP
ENNS RIVER
MILITARY HYDROLOGY
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by
Drawn by



GENERAL PROFILE OF THE INN R.
Übersichts-Längenprofil
The Inn R. km 416.29 - 292.00 (from Martinsbruck to Innsbrucke
des Inn km 416.29 - 292.00 (von Martinsbruck bis Innsbruck)
Horizontal Scale 1:250,000, Vertical Scale 1:2000
Längen 1:250.000 Höhen 1:2000
Legende:
Brücke, Steg
Bridge
Zubringer
Tributary
Pegel
Gage
Schreibpegel
Recording gage
Aufgelassener Pegel
Inoperative gage
Pegel mit Tabellen
Gage w/records in Kadaster
Pegel Nullpunkt
Gage Zero
Limit of river reach for purpose of power.
Pegel Martinsbruck
Pegel Schalklhof
Pegel Ried
Pegel Prutz
Pegel Pontlatzer-brucke
Pegel Landeck
Pegel Perjen
Pegel Imst
Pegel Magerbach
Pegel Magerbach
Schreibpegel d WTK
Pegel Telfs
Pegel Zirl
Pegel Mühlau
Pegel Innsbruck
Niederwasser-Spiegellinie
Low water profile
Energiedargebot bei MQ
Power supply at MQ
Einzugsgebiet in km²
Drainage Area km²
Mittelwasserführung MQ
Mean water flow MQ
FLOW SUPPLY LINE
Spendenlinien.
Innsbruck
Telfs
Magerbach
Pitzbachmündung
Perjen
Ried
Martinsbruck
Mq Linie
Scale for Mq
Scale for Nq
liters/sec./km²
Kilometerage
Kilometerteilung
Maßstab für die Höhen in m ü.A.
Scale for Elevation (meters above Adriatic)
Maßstab für die Einzugsgebiete in km²
Scale for Drainage Area km²
Maßstab für das Energiedargebot in GWh
Scale for power supply (million Kilowatt hr.)
Maßstab für MQ (m³/s)
Scale for MQ (m³/sec.)
Landeck
Zams
Imst
Telfs
Innsbruck
AUSTRIAN ALPS
RIVER PROFILE
UPPER INN RIVER
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by
Drawn by
PLATE 3a

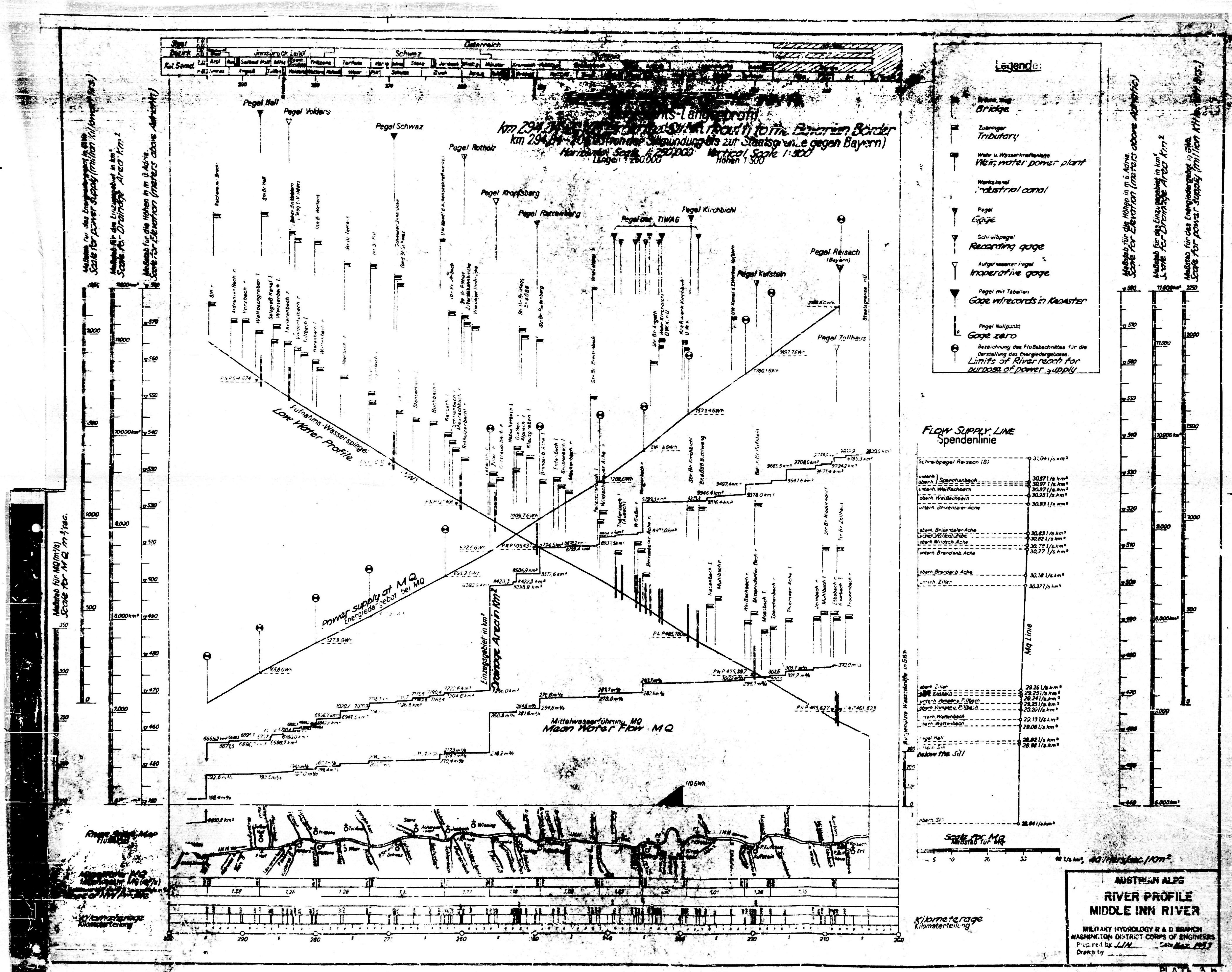
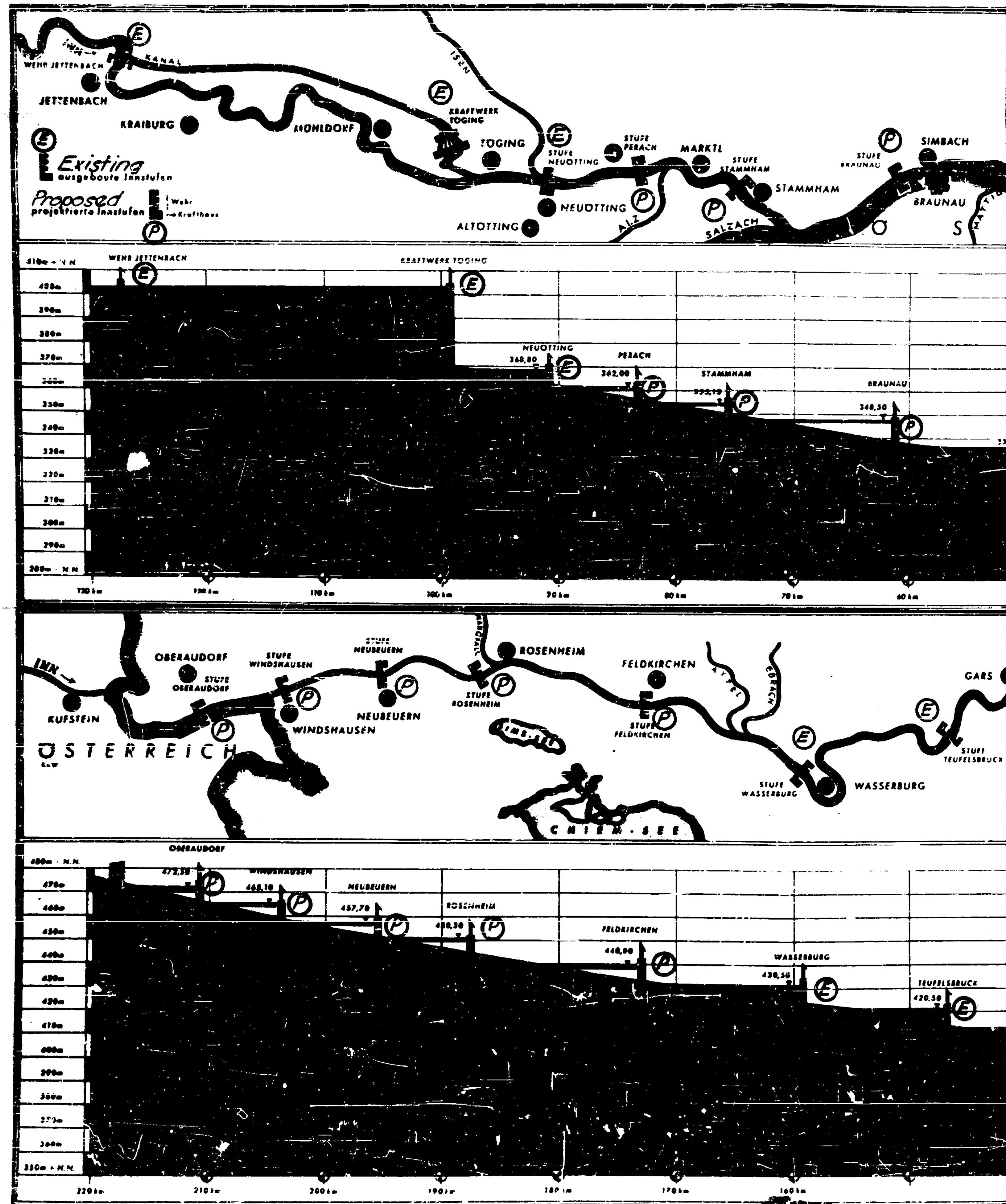
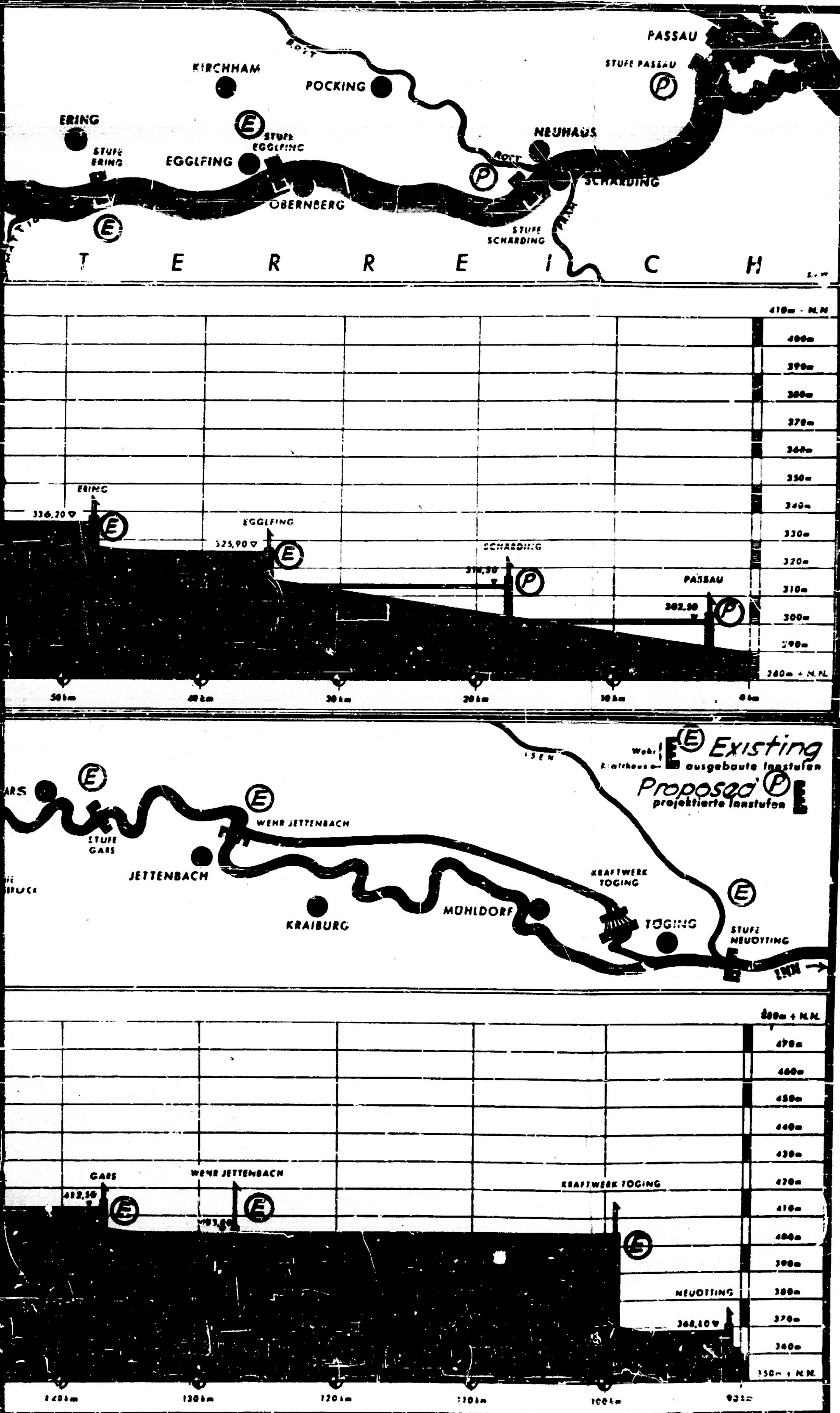

Legende:
Bridge
Tributary
Weir, water power plant
Industrial canal
Gage
Recording gage
Inoperative gage
Gage wirecords in Kadaster
Gage zero
Limits of River reach for purpose of power supply
Pegel Hall
Pegel Volders
Pegel Schwaz
Pegel Rotholz
Pegel Kropfsberg
Pegel Rattenberg
Pegel Kirchbichl
TIWAG
Pegel Kufstein
Pegel Reisach
Pegel Zollhaus
Horizontal Scale 1:250,000 Vertical Scale 1:500
Längen 1:250000 Höhen 1:500
Low Water Profile
Power supply at MQ
Energiedargebot bei MQ
Drainage Area in km²
Einzugsgebiet in km²
Mittelwasserführung MQ
Mean Water Flow MQ
Flow Supply Line
Spendenlinie
MQ Linie
Scale for MQ
Maßstab für MQ
40 l/sec/km²
Scale for M Q m³/sec.
Maßstab für MQ (m³/s)
Scale for Drainage Area km²
Scale for Elevation (meters above Adriatic)
Scale for power supply (million kilowatt-hrs)
River Sketch Map
Flußskizze
Kilometerage
Kilometerteilung
AUSTRIAN ALPS
RIVER PROFILE
MIDDLE INN RIVER
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by
Drawn by

PLATE 3 b



WEHR JETTENBACH
KANAL
JETTENBACH
KRAIBURG
MÜHLDORF
ISEN
KRAFTWERK TÖGING
TÖGING
STUFE NEUÖTTING
STUFE PERACH
MARKTL
STUFE STAMMHAM
STAMMHAM
STUFE BRAUNAU
SIMBACH
BRAUNAU
NEUÖTTING
ALTÖTTING
ALZ
SALZACH
Existing
ausgebaute Innstufen
Proposed
projektierte Innstufen
Wehr
Krafthaus
WEHR JETTENBACH
KRAFTWERK TÖGING
NEUÖTTING
PERACH
STAMMHAM
BRAUNAU
368,80
362,00
348,50
INN
OBERAUDORF
STUFE OBERAUDORF
STUFE WINDSHAUSEN
STUFE NEUBEUERN
ROSENHEIM
STUFE ROSENHEIM
FELDKIRCHEN
STUFE FELDKIRCHEN
GARS
KUFSTEIN
NEUBEUERN
WINDSHAUSEN
ÖSTERREICH
STUFE WASSERBURG
WASSERBURG
STUFE TEUFELSBRUCK
CHIEM-SEE
OBERAUDORF
WINDSHAUSEN
NEUBEUERN
ROSENHEIM
FELDKIRCHEN
WASSERBURG
TEUFELSBRUCK
466,10
457,70
448,00
430,50
420,50



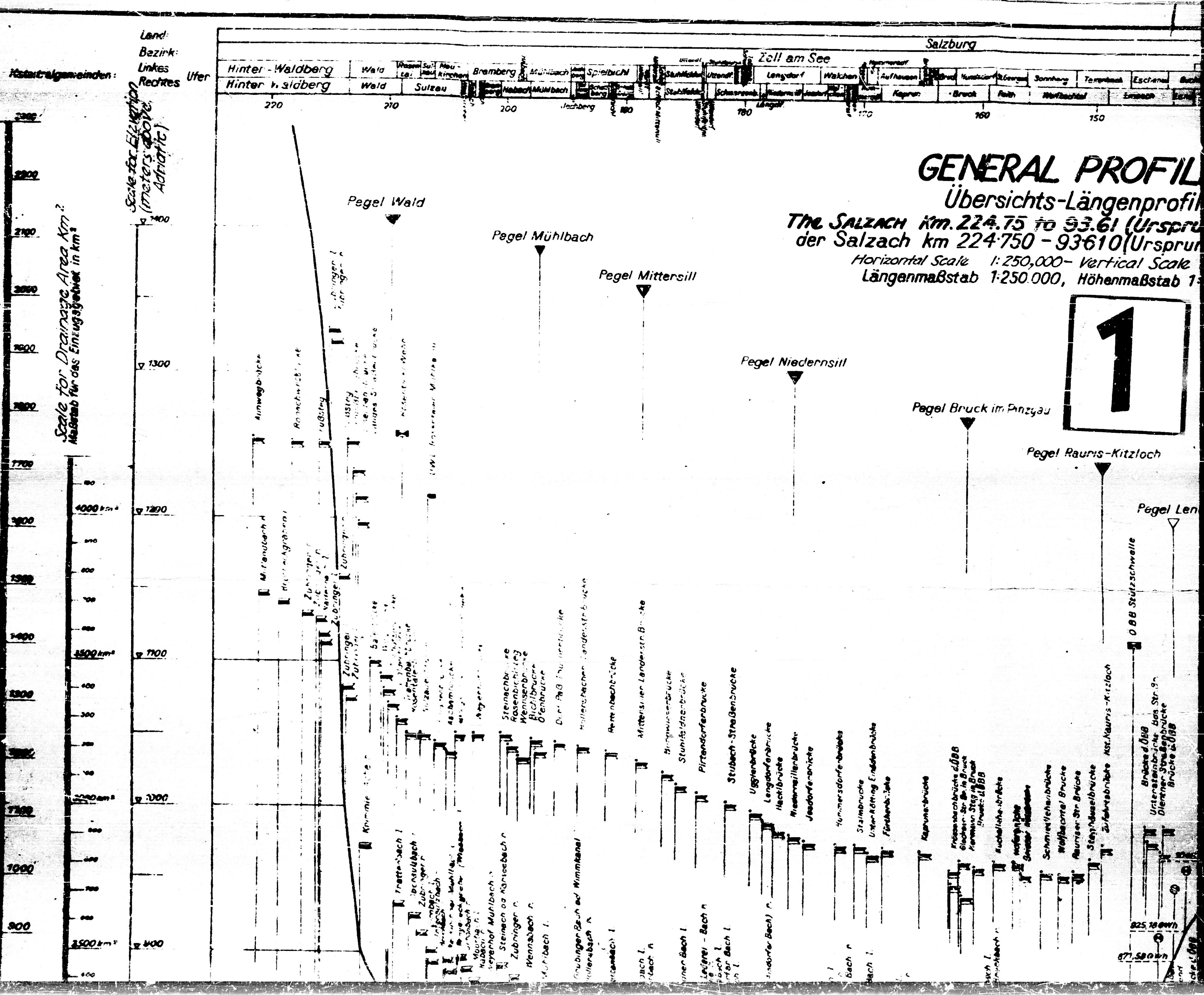
SOURCE:
"Innwerk A.G.," 1950.
(Referene No 41)

AUSTRIAN ALPS

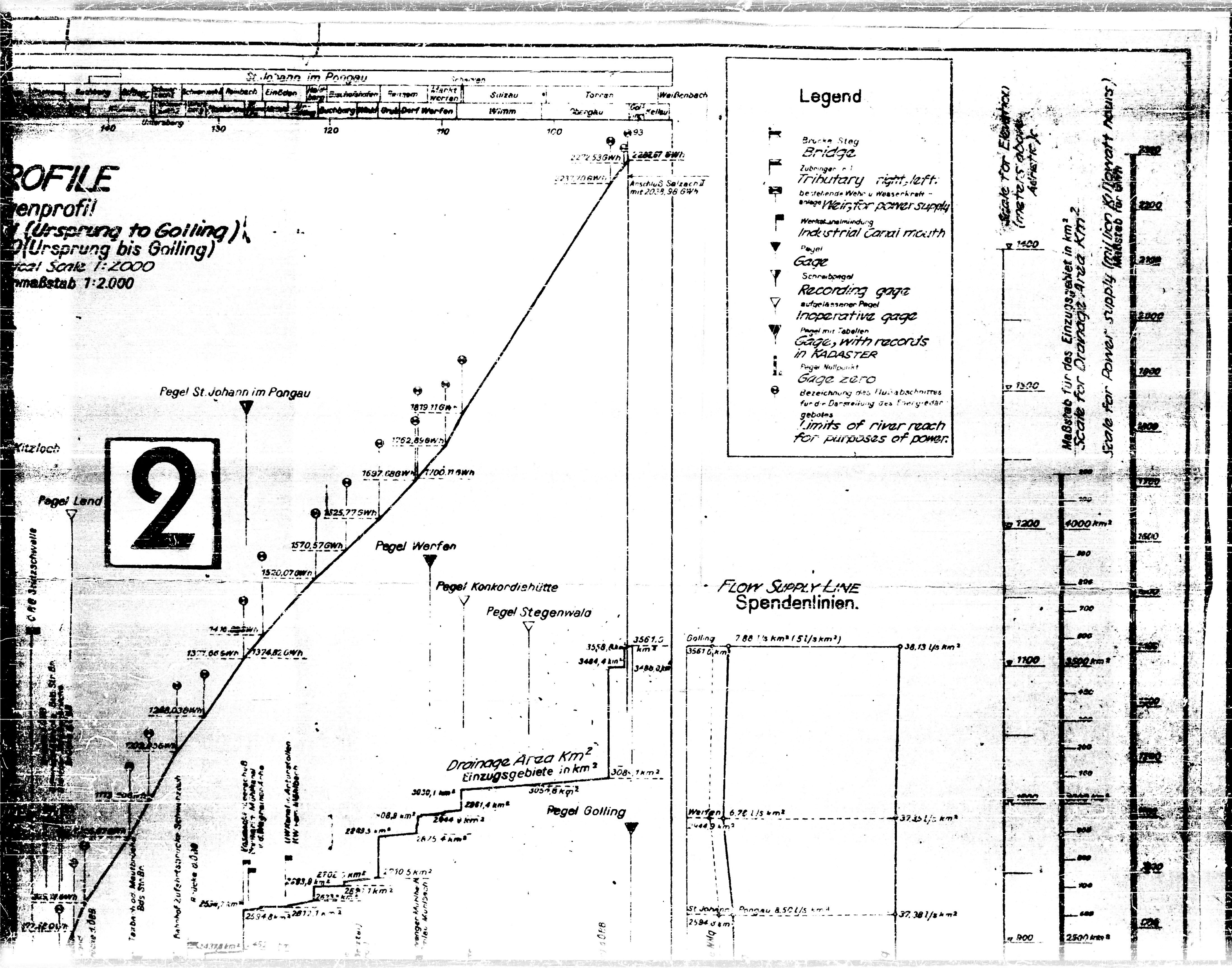
RIVER PROFILE

LOWER INN RIVER

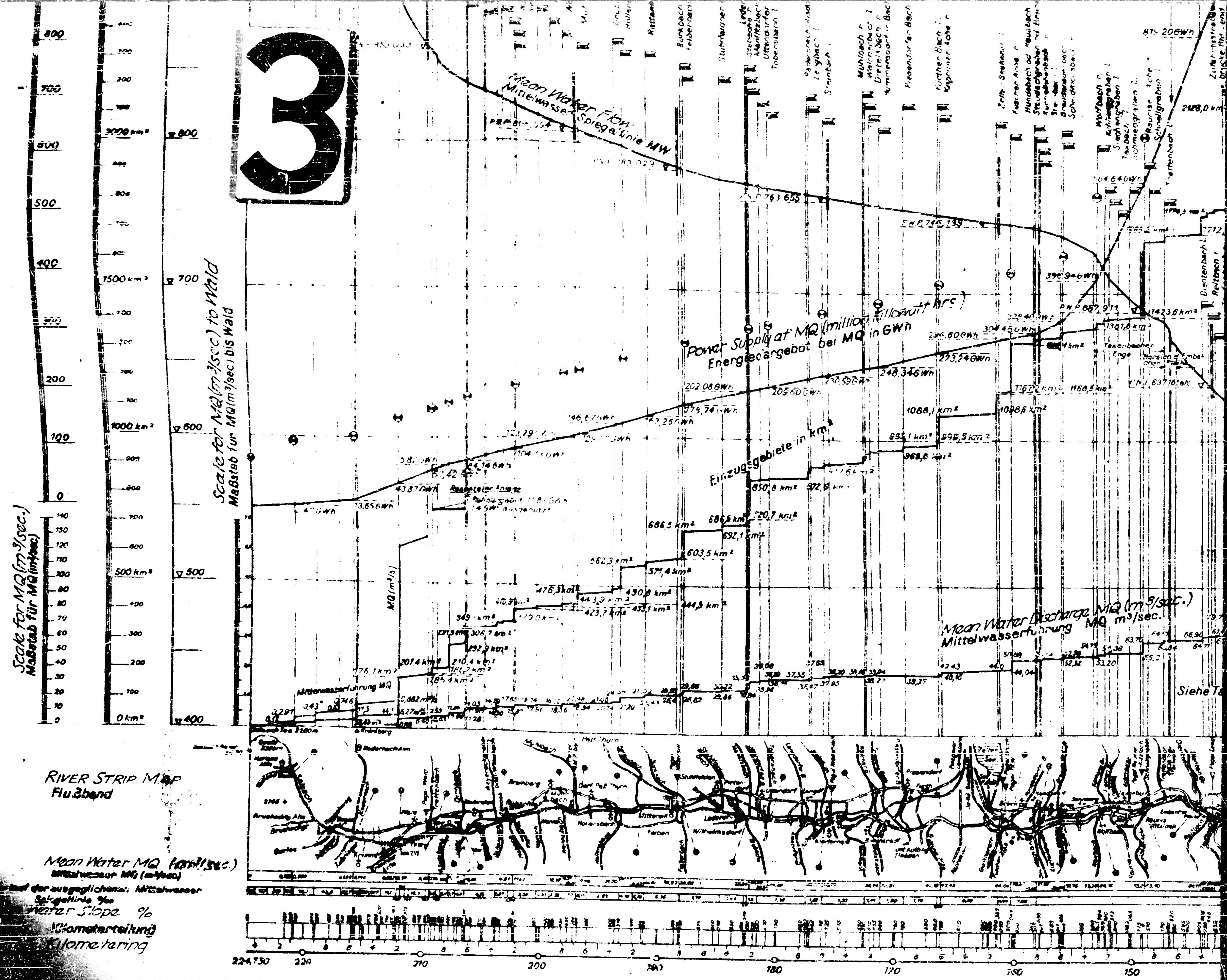
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JJH Date Nov. 1953
Drawn by ________

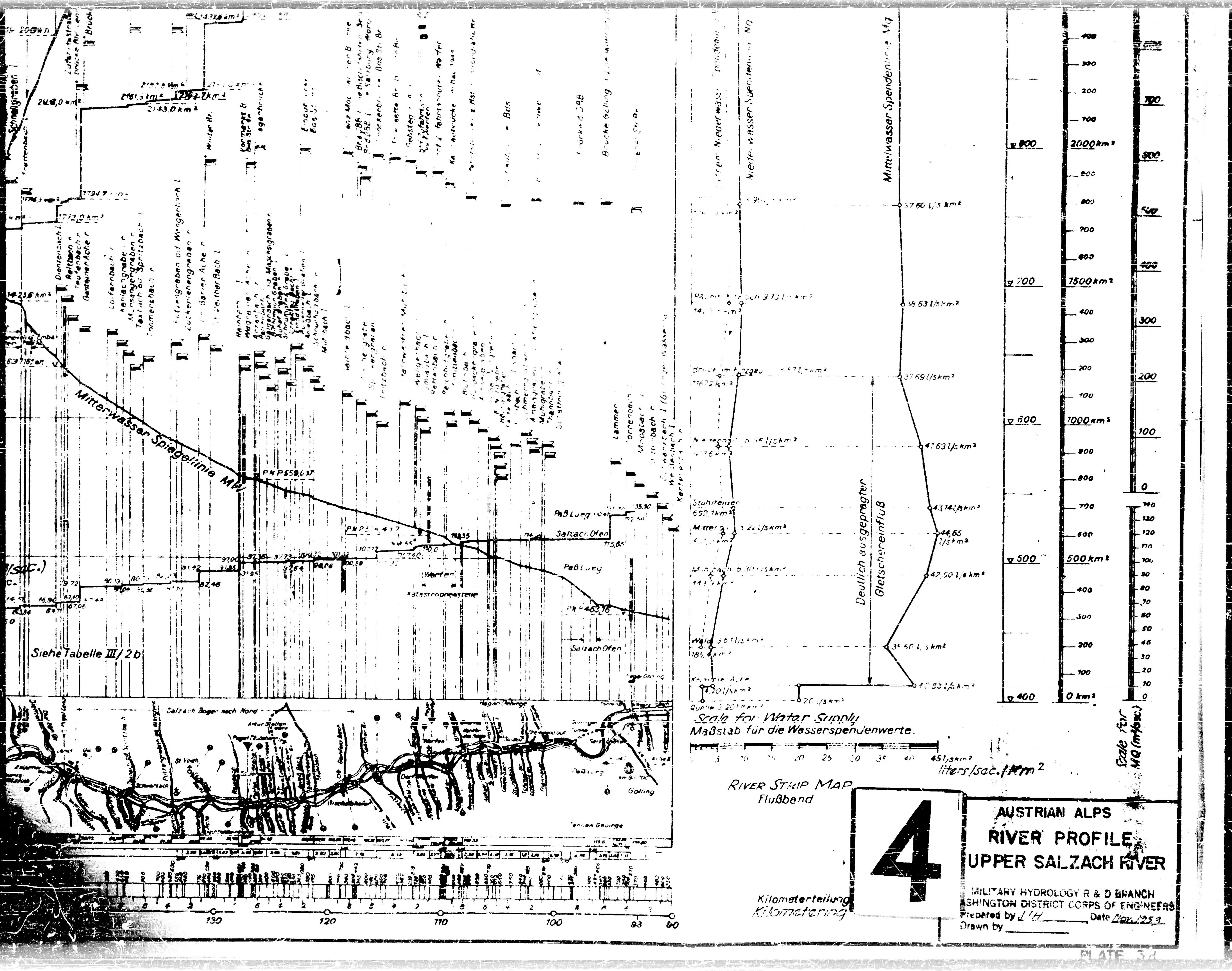


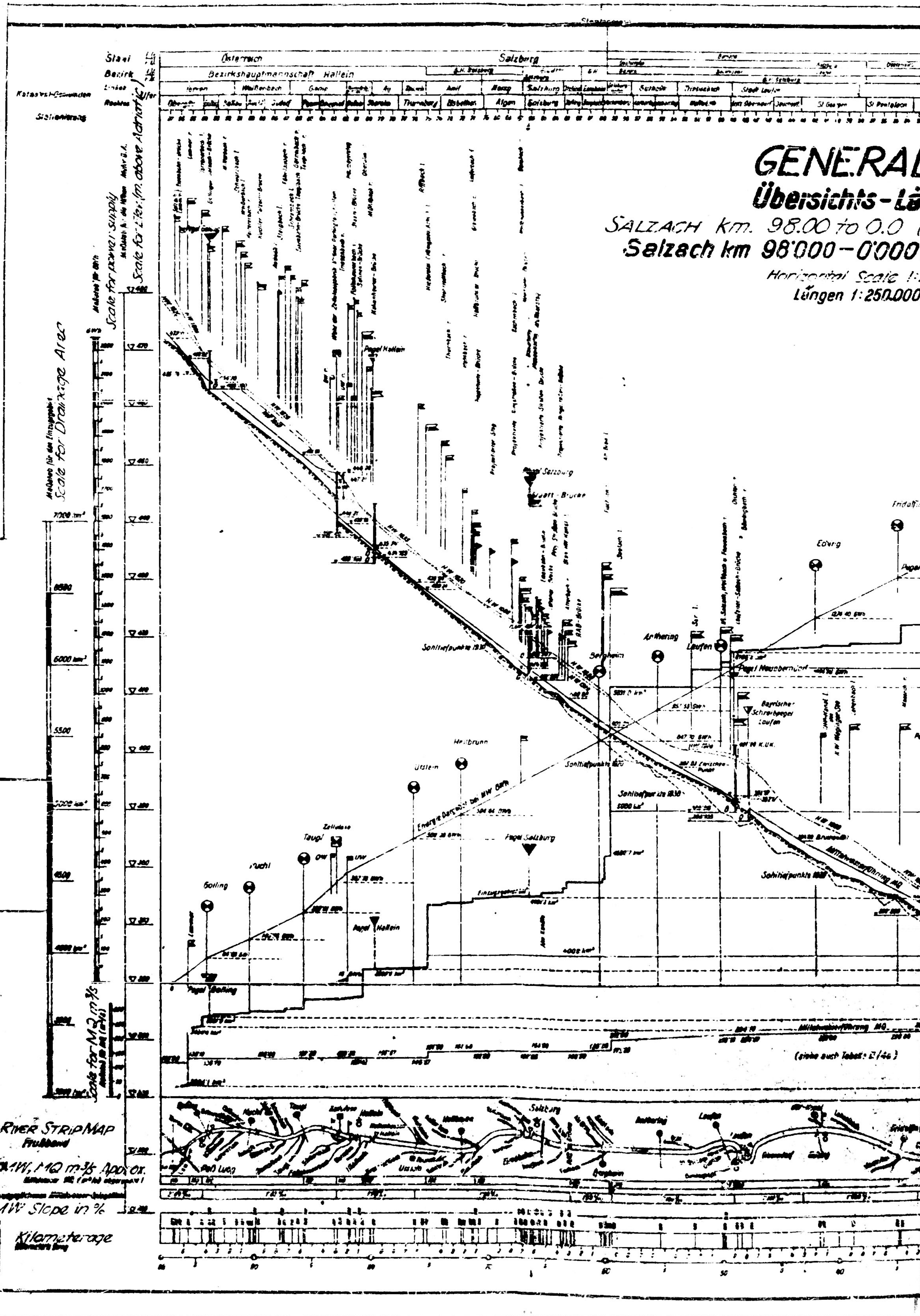
GENERAL PROFIL
Übersichts-Längenprofil
The Salzach Km. 224.75 to 93.61 (Urspru
der Salzach km 224·750 - 93·610 (Ursprun
Horizontal Scale 1:250,000 - Vertical Scale
Längenmaßstab 1:250.000, Höhenmaßstab 1:
1
Salzburg
Zell am See
Land:
Bezirk:
Linkes
Rechtes
Ufer
Katastralgemeinden:
Hinter-Waldberg
Wald
Sulzau
Bramberg
Mühlbach
Spielbichl
Lengdorf
Walchen
Aufhausen
Sonnberg
Eschenau
Kaprun
Bruck
Jechberg
Längdf.
220
210
200
190
180
170
160
150
Scale for Drainage Area Km²
Maßstab für das Einzugsgebiet in km²
Scale for Elevation (meters above Adriatic)
Pegel Wald
Pegel Mühlbach
Pegel Mittersill
Pegel Niedernsill
Pegel Bruck im Pinzgau
Pegel Rauris-Kitzloch
Pegel Lend
1400
1300
1200
1100
1000
900
4000 km²
3500 km²
3000 km²
2500 km²
Almwegbrücke
Mittersiller Landesstr. Brücke
Stubach-Straßenbrücke
Pirtendorferbrücke
Kaprunerbrücke
ÖBB Stützschwelle
Hst. Rauris-Kitzloch
Wennsbach l.
Steinach od. Kaltenbach r.
Trattenbach l.
Grubinger Bach od. Wimmkanal
925,18 GWh
871,58 GWh



St. Johann im Pongau
Schwarzach
Bischofshofen
Sulzau
Torren
Weißenbach
Einöden
Markt Werfen
Dorf Werfen
Wimm
Untersberg
140
130
120
110
100
93
ROFILE
enprofil
(Ursprung to Golling)
(Ursprung bis Golling)
cal Scale 1:2000
maßstab 1:2.000
2
Kitzloch
Pegel Lend
Pegel St. Johann im Pongau
Pegel Werfen
Pegel Konkordiahütte
Pegel Stegenwald
Pegel Golling
2272.53 GWh
2282.67 GWh
2237.70 GWh
Anschluß Salzach II mit 2038.98 GWh
1819.11 GWh
1762.89 GWh
1697.68 GWh
1700.11 GWh
1625.77 GWh
1570.57 GWh
1520.07 GWh
1416 GWh
1374.82 GWh
1288.03 GWh
Drainage Area Km²
Einzugsgebiete in km²
3561.0 km²
3558.8 km²
3484.4 km²
3486.0 km²
3084.1 km²
3030.1 km²
3058.6 km²
2961.4 km²
2944.9 km²
2875.4 km²
2883.3 km²
2902.3 km²
2910.5 km²
2583.8 km²
2612.1 km²
2594.8 km²
Legend
Brücke Steg
Bridge
Zubringer r. l.
Tributary right, left.
bestehende Wehr u. Wasserkraftanlage
Weir for power supply
Werkskanalmündung
Industrial Canal mouth
Pegel
Gage
Schreibpegel
Recording gage
aufgelassener Pegel
Inoperative gage
Pegel mit Tabellen
Gage, with records in KADASTER
Pegel Nullpunkt
Gage zero
Bezeichnung des Flußabschnittes für die Darstellung des Energiedargebotes
Limits of river reach for purposes of power.
FLOW SUPPLY LINE
Spendenlinien.
Golling 7.88 l/s km² (5 l/s km²)
38.13 l/s km²
Werfen 6.78 l/s km²
37.35 l/s km²
St. Johann i. Pongau 8.50 l/s km²
37.38 l/s km²
Scale for Elevation (meters above Adriatic)
Maßstab für das Einzugsgebiet in km²
Scale for Drainage Area Km²
Scale for Power supply (million Kilowatt hours)
Maßstab für GWh
1400
1300
1200
1100
1000
900
4000 km²
3500 km²
2500 km²

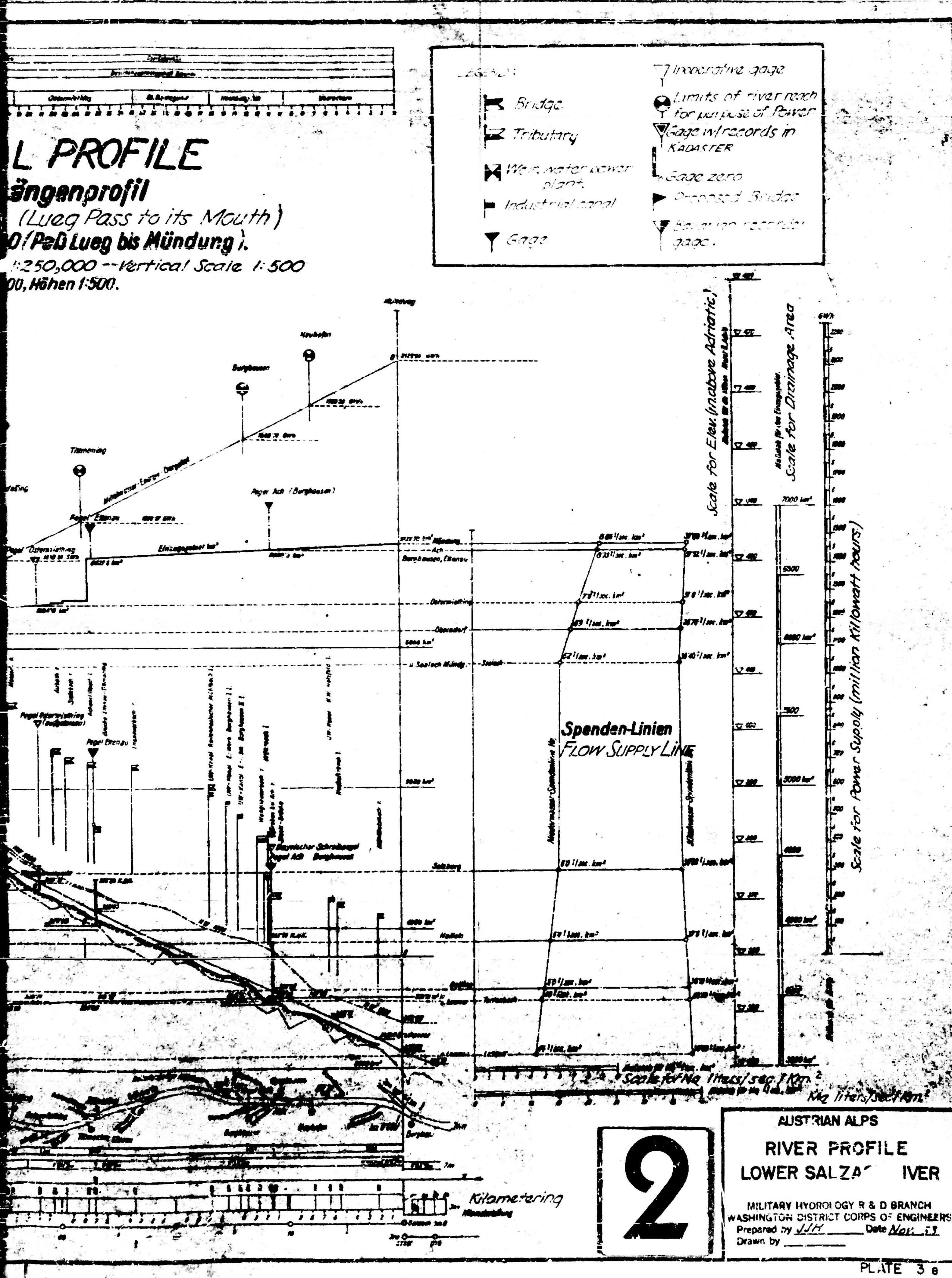

3
Scale for MQ (m³/sec.)
Maßstab für MQ (m³/sec)
Scale for MQ (m³/sec.) to Wald
Maßstab für MQ (m³/sec) bis Wald
Mean Water Flow
Mittelwasser-Spiegellinie MW
Power Supply at MQ (million kilowatt hrs.)
Energieangebot bei MQ in GWh
Einzugsgebiete in km²
Mean Water Discharge MQ (m³/sec.)
Mittelwasserführung MQ m³/sec.
Mittelwasserführung MQ
MQ (m³/s)
RIVER STRIP MAP
Flußband
Mean Water MQ (m³/sec.)
Mittelwasser MQ (m³/sec)
Water Slope %
Kilometerteilung
Kilometering
Siehe Ta


Mittelwasser Spiegellinie MW
Siehe Tabelle III/2b
Scale for Water Supply
Maßstab für die Wasserspendenwerte
liters/sec./km²
Mittelwasser Spendenlinie Mq
Deutlich ausgeprägter Gletschereinfluß
Scale for MQ (m³/sec.)
RIVER STRIP MAP
Flußband
Kilometerteilung
Kilometering
Paß Lueg
Salzach Ofen
Werfen
Golling
4
AUSTRIAN ALPS
RIVER PROFILE
UPPER SALZACH RIVER
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by
Date
Drawn by
PLATE 3d

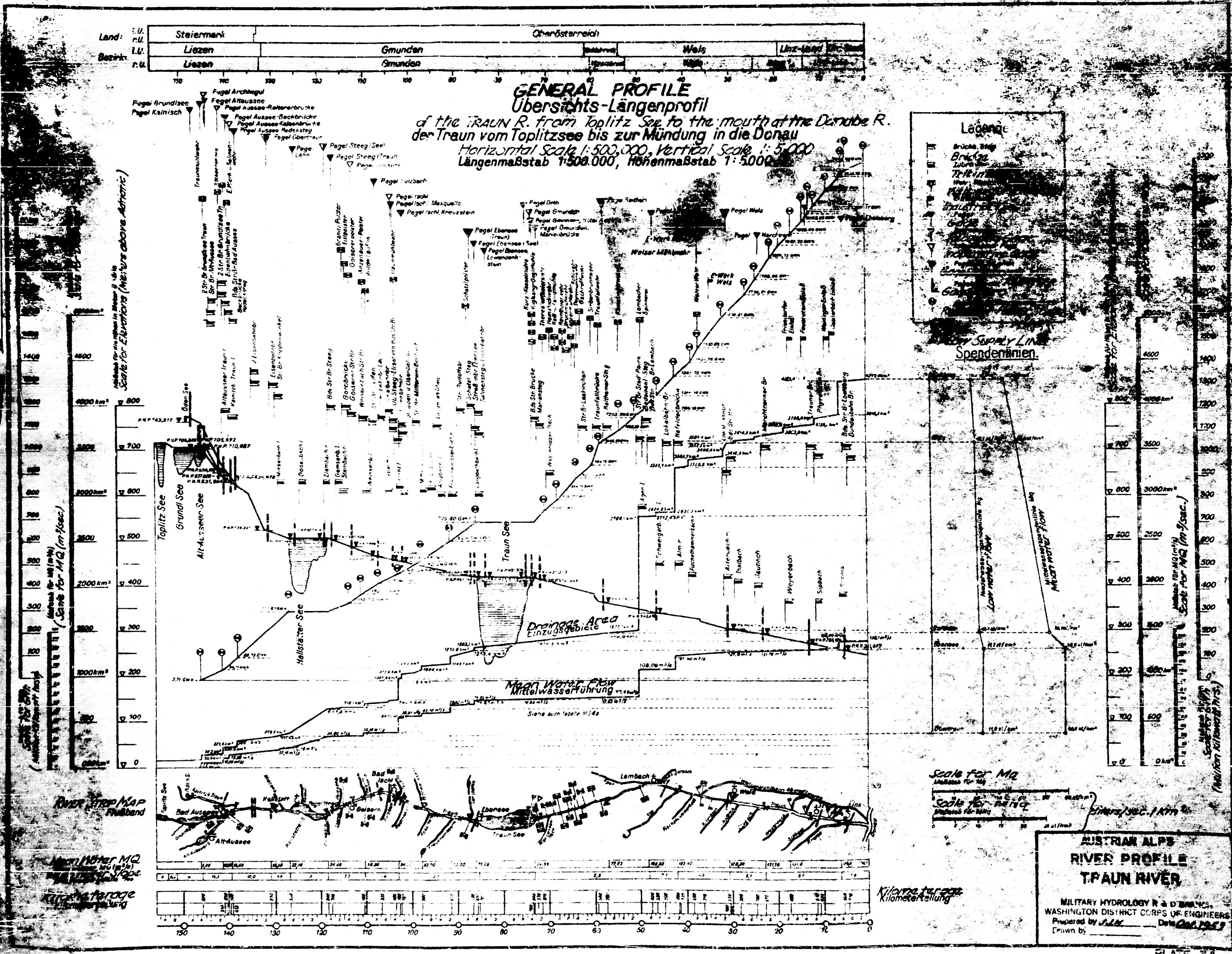


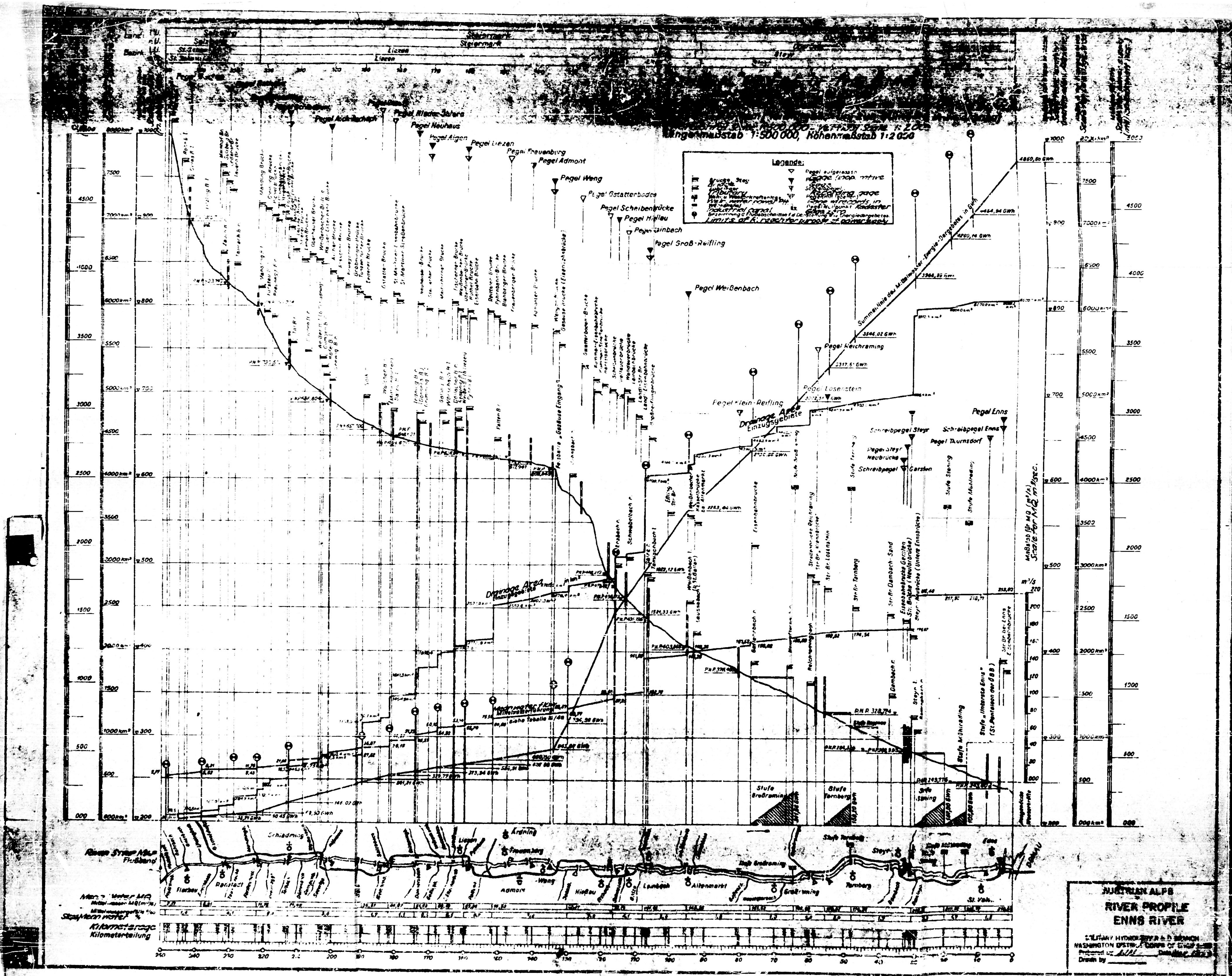
Österreich
Salzburg
Bezirkshauptmannschaft Hallein
SALZACH km. 98.00 to 0.0
Salzach km 98'000–0'000
Längen 1:250.000
Scale for Drainage Area
Scale for power supply
Pegel Hallein
Pegel Salzburg
Sohltiefpunkte 1930
Golling
Kuchl
Taugl
Urstein
Hellbrunn
Bergheim
Anthering
Laufen
Pegel Golling
Energie Darstellung bei MW
Mittelwasserführung MQ
(siehe auch Tabelle D/46)
RIVER STRIP MAP
Flußband
MW Slope in %
Kilometerage

1



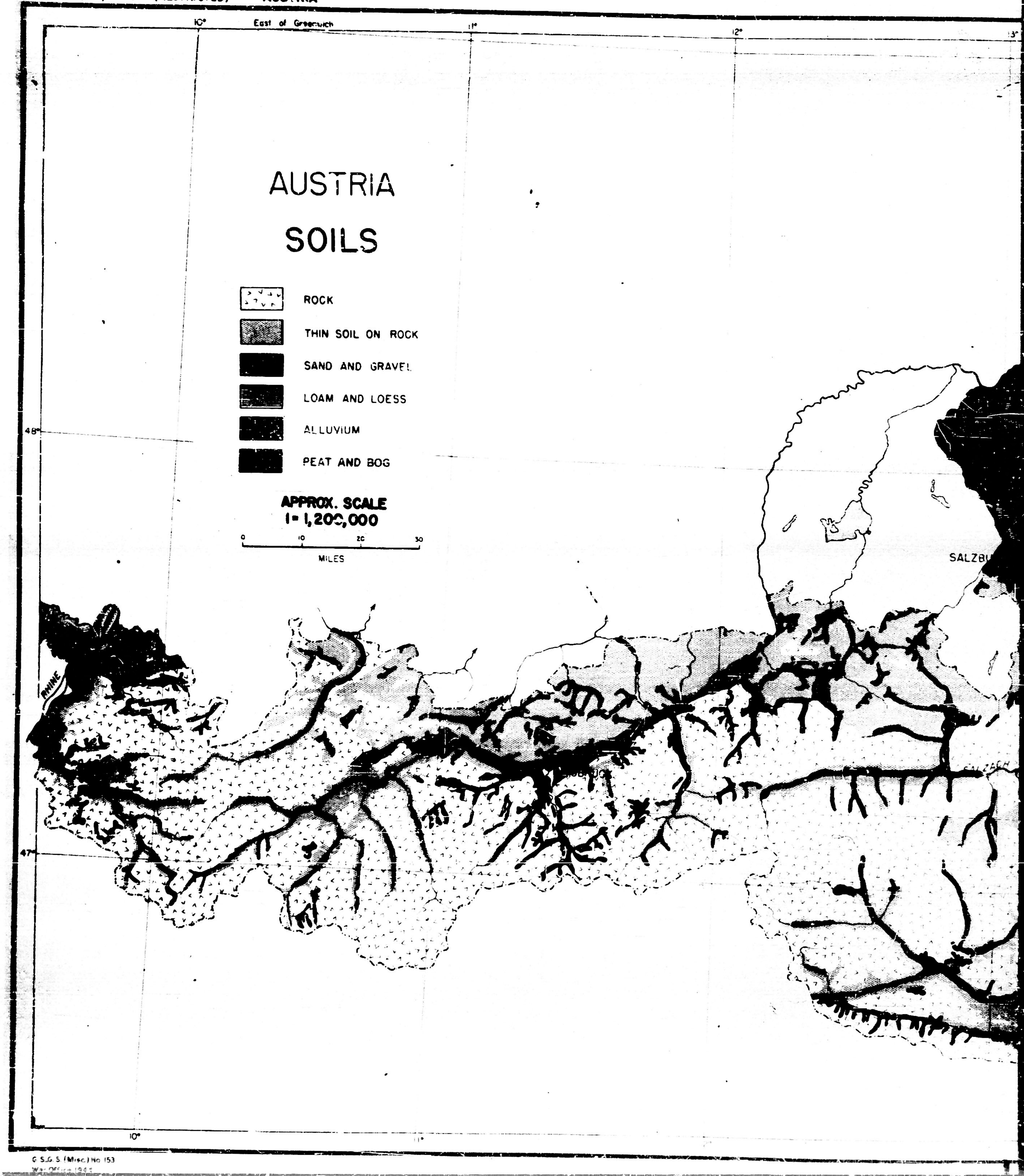
L. PROFILE
ängenprofil
(Lueg Pass to its Mouth)
0 (Paß Lueg bis Mündung).
1:250,000 -- Vertical Scale 1:500
00, Höhen 1:500.
LEGEND:
Bridge
Tributary
Weir water power plant
Industrial canal
Gage
Inoperative gage
Limits of river reach for purpose of Power
Gage w/records in KADASTER
Gage zero
Proposed Bridge
Bavarian recording gage.
Tittmoning
Burghausen
Neuhofen
Pegel Ach (Burghausen)
Pegel Ettenau
Pegel Ostermiething
Einzugsgebiet km²
Mündung
Ach
Burghausen, Ettenau
Ostermiething
Oberndorf
u. Saalach Mündg.
Saalach
Salzburg
Hallein
Spenden-Linien
FLOW SUPPLY LINE
Scale for Elev. (m above Adriatic)
Scale for Drainage Area
Scale for Power Supply (million Kilowatt hours)
GWh
Scale for Mq liters/sec/Km.²
Mq liters/sec/Km.²
Kilometering
Bayrischer Schreibpegel Pegel Ach Burghausen
2
AUSTRIAN ALPS
RIVER PROFILE
LOWER SALZA IVER
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JJH Date Nov. 53
Drawn by
PLATE 3 e


GENERAL PROFILE
Übersichts-Längenprofil
of the TRAUN R. from Toplitz See to the mouth at the Danube R.
der Traun vom Toplitzsee bis zur Mündung in die Donau
Horizontal Scale 1:500,000, Vertical Scale 1:5,000
Längenmaßstab 1:500.000, Höhenmaßstab 1:5.000
Land:
Bezirk:
Steiermark
Oberösterreich
Liezen
Gmunden
Wels
Legende
Low Supply Lines
Spendenlinien
Scale for Elevations (meters above Adriatic)
Scale for MQ (m³/sec.)
Toplitz See
Grundl See
Alt-Ausseer See
Hallstätter See
Traun See
Drainage Area
Einzugsgebiete
Mean Water Flow
Mittelwasserführung
Low water flow
Mean water flow
Scale for MQ
Liters/sec./Km²
River Strip Map
Flußband
Bad Aussee
Alt-Aussee
Bad Ischl
Goisern
Ebensee
Traun See
Lambach
Wels
Linz
Mean Water MQ
Kilometerage
Kilometerteilung
AUSTRIAN ALPS
RIVER PROFILE
TRAUN RIVER
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by
Drawn by
Date
PLATE

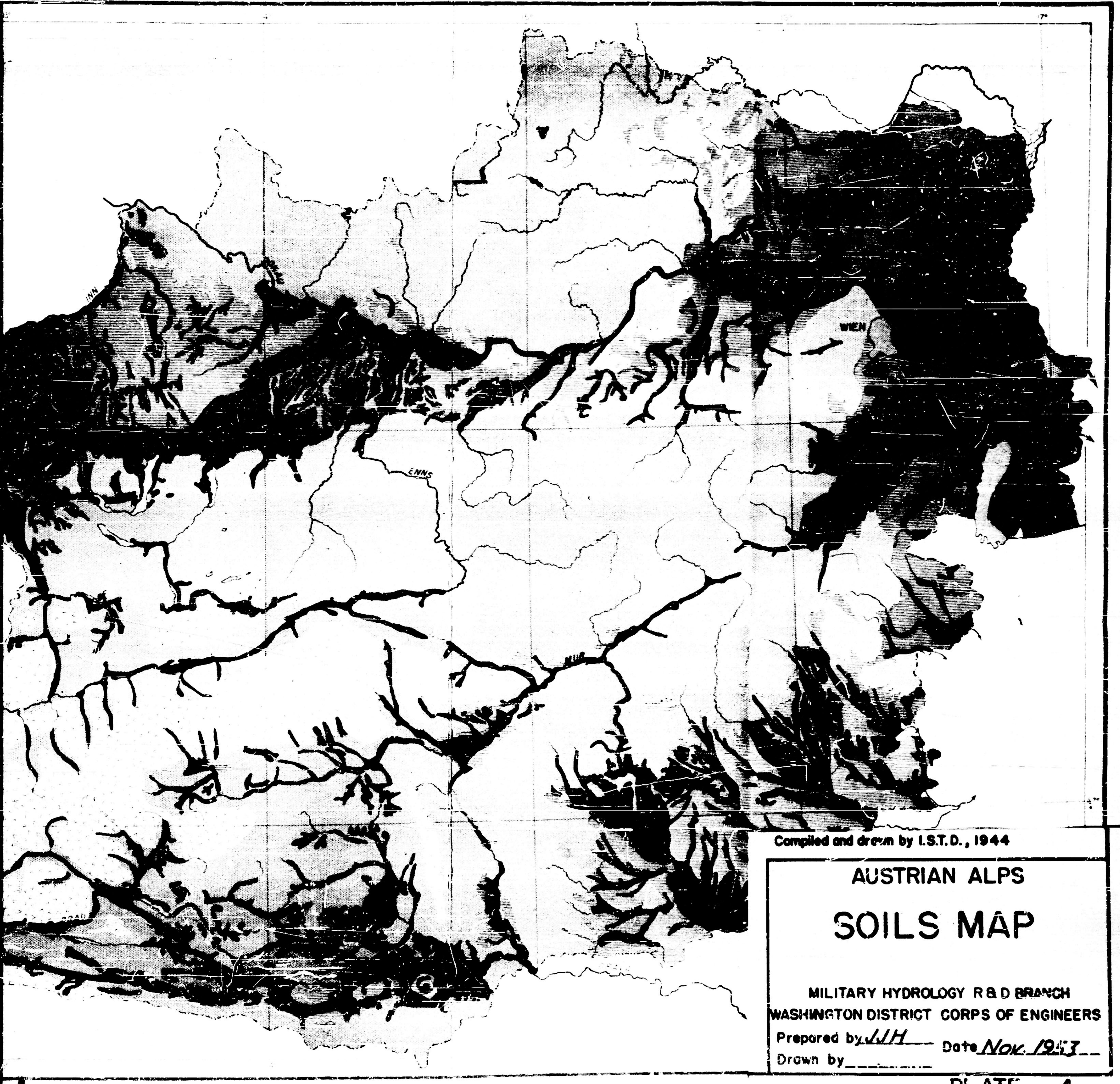


Längenmaßstab 1:500 000, Höhenmaßstab 1:2 000
Legende:
Limits of K. reach for purpose of power supply
Pegel Admont
Pegel Weng
Pegel Gstattenboden
Pegel Schreibenbrücke
Pegel Hieflau
Pegel Groß-Reifling
Pegel Weißenbach
Pegel Reichraming
Pegel Losenstein
Pegel Klein-Reifling
Pegel Enns
Schreibpegel Enns
Pegel Thurnsdorf
Schreibpegel Steyr
Schreibpegel Garsten
Pegel Neuhaus
Pegel Aigen
Pegel Liezen
Pegel Frauenburg
Drainage Area
Einzugsgebiete
Summenlinie des Mittelwasser-Energie-Dargebotes in GWh
Maßstab für MQ (m^3/s)
Scale for MQ m^3/sec.
Stufe Großraming
Stufe Ternberg
Stufe Staning
Stufe Mühlrading
River Strip Map
Flußband
Mean Water MQ
Mittelwasser MQ (m^3/s)
Kilometerage
Kilometerteilung
Schladming
Liezen
Admont
Weng
Hieflau
Landl
Altenmarkt
Großraming
Ternberg
Steyr
Enns
St. Valentin
AUSTRIAN ALPS
RIVER PROFILE
ENNS RIVER
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT, CORPS OF ENGINEERS
Drawn by

PLATE 3a



G.S.G.S. (Misc) No 153



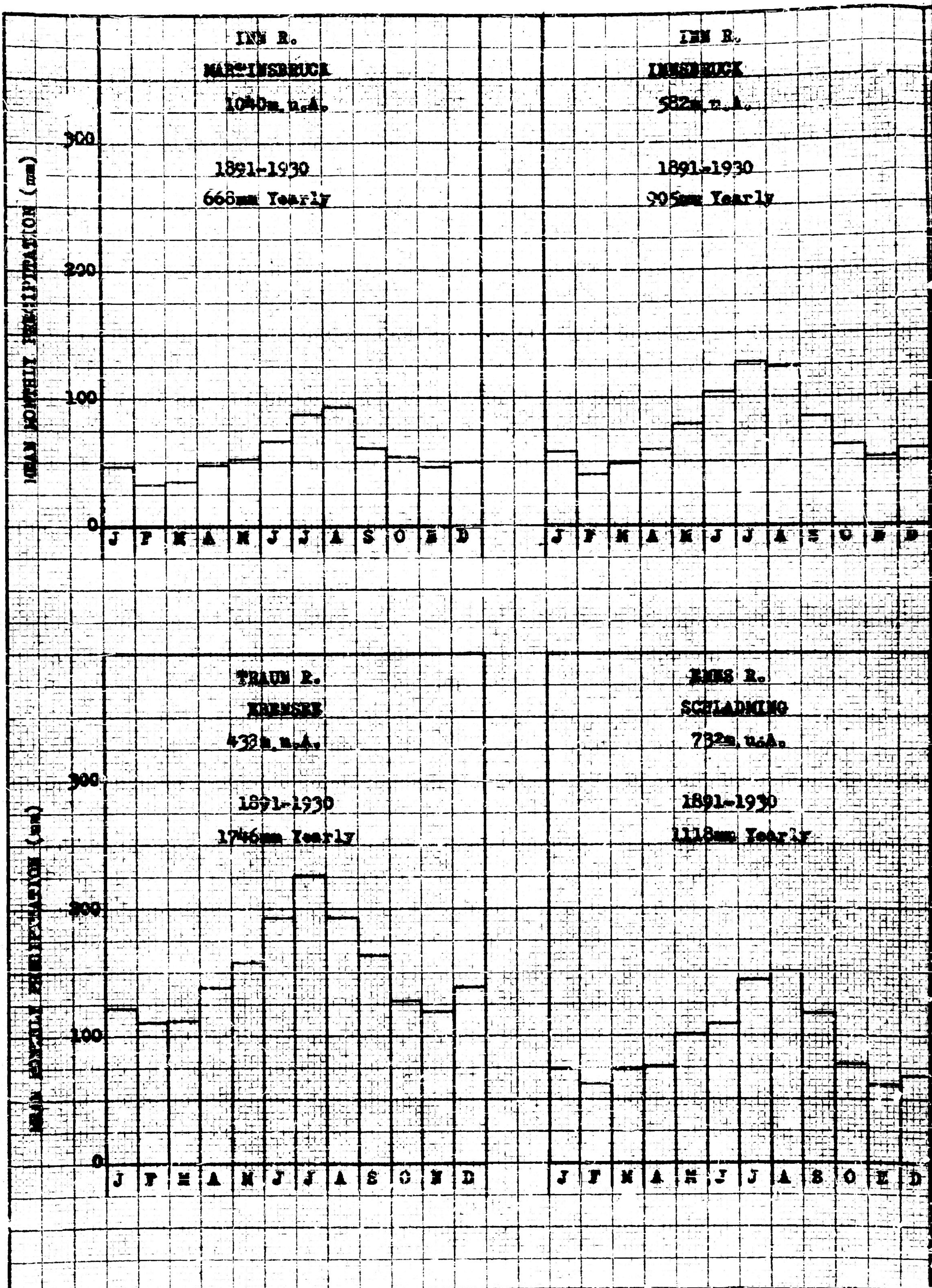
Compiled and drawn by I.S.T.D., 1944

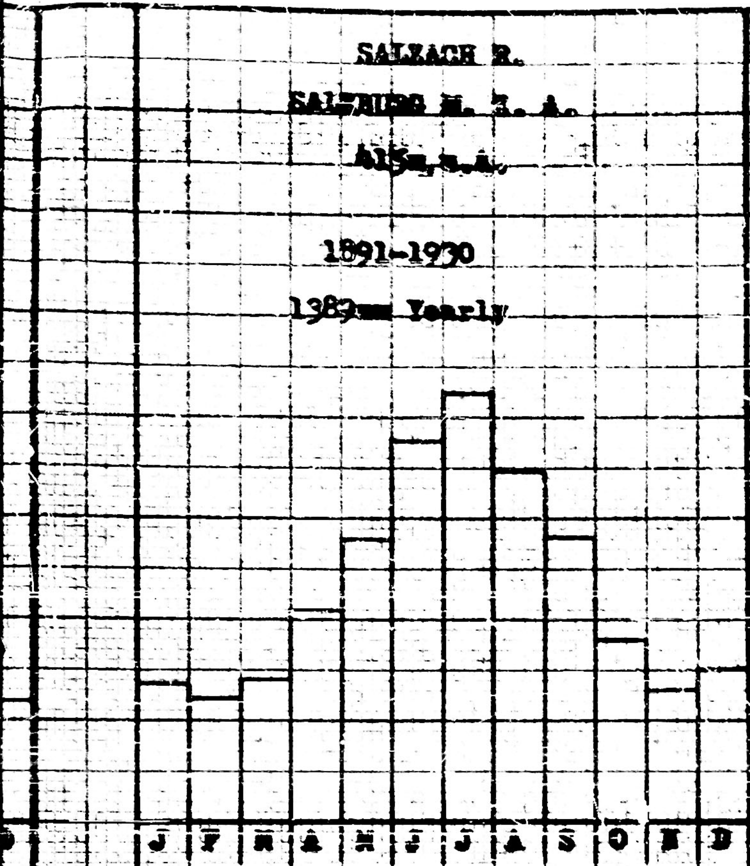
AUSTRIAN ALPS

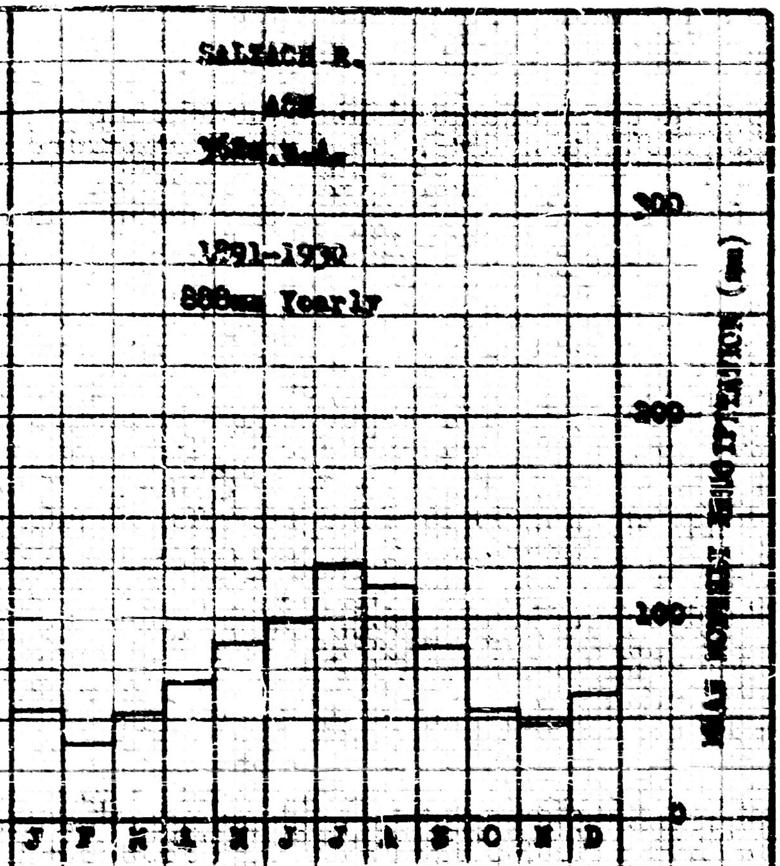
SOILS MAP

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JJH Date Nov. 1953
Drawn by ________

PLATE 4


INN R.
MARTINSBRUCK
1040m. u.A.
1891-1930
666mm Yearly
INN R.
INNSBRUCK
582m. u.A.
1891-1930
905mm Yearly
TRAUN R.
KREMSEE
433m. u.A.
1891-1930
1746mm Yearly
ENNS R.
SCHLADMING
732m. u.A.
1891-1930
1118mm Yearly
MEAN MONTHLY PRECIPITATION (mm)
0
100
200
300
J F M A M J J A S O N D



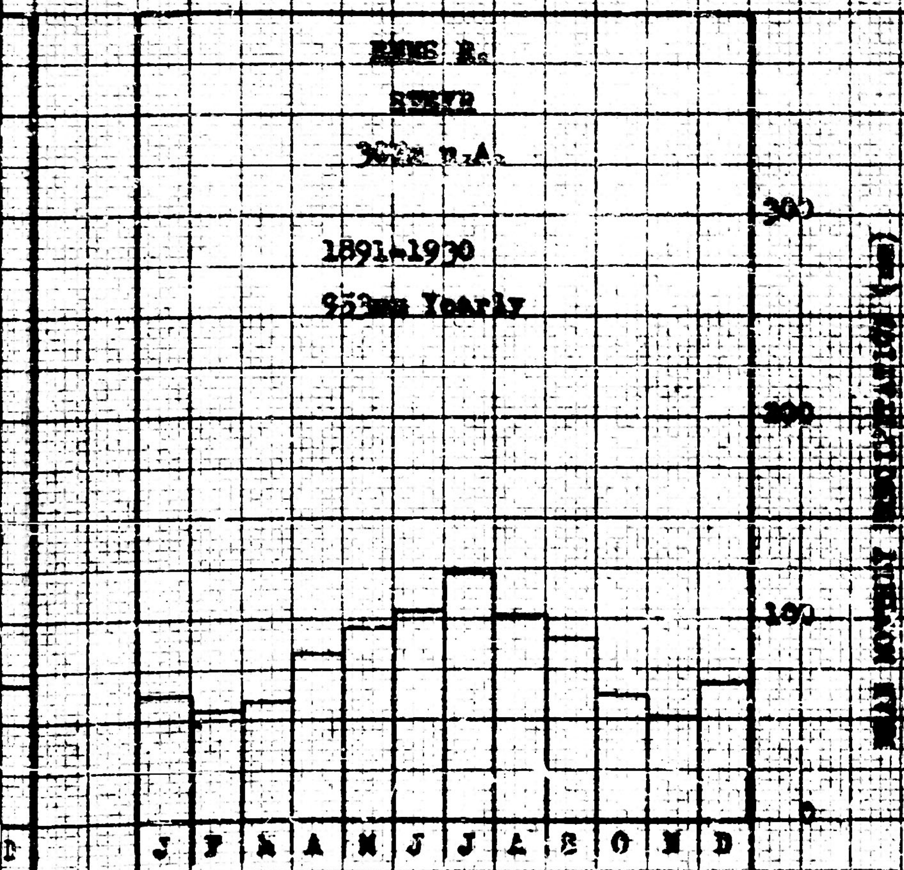


NOTE:

[illegible]

[illegible]

See Table 4 for summary of gage data

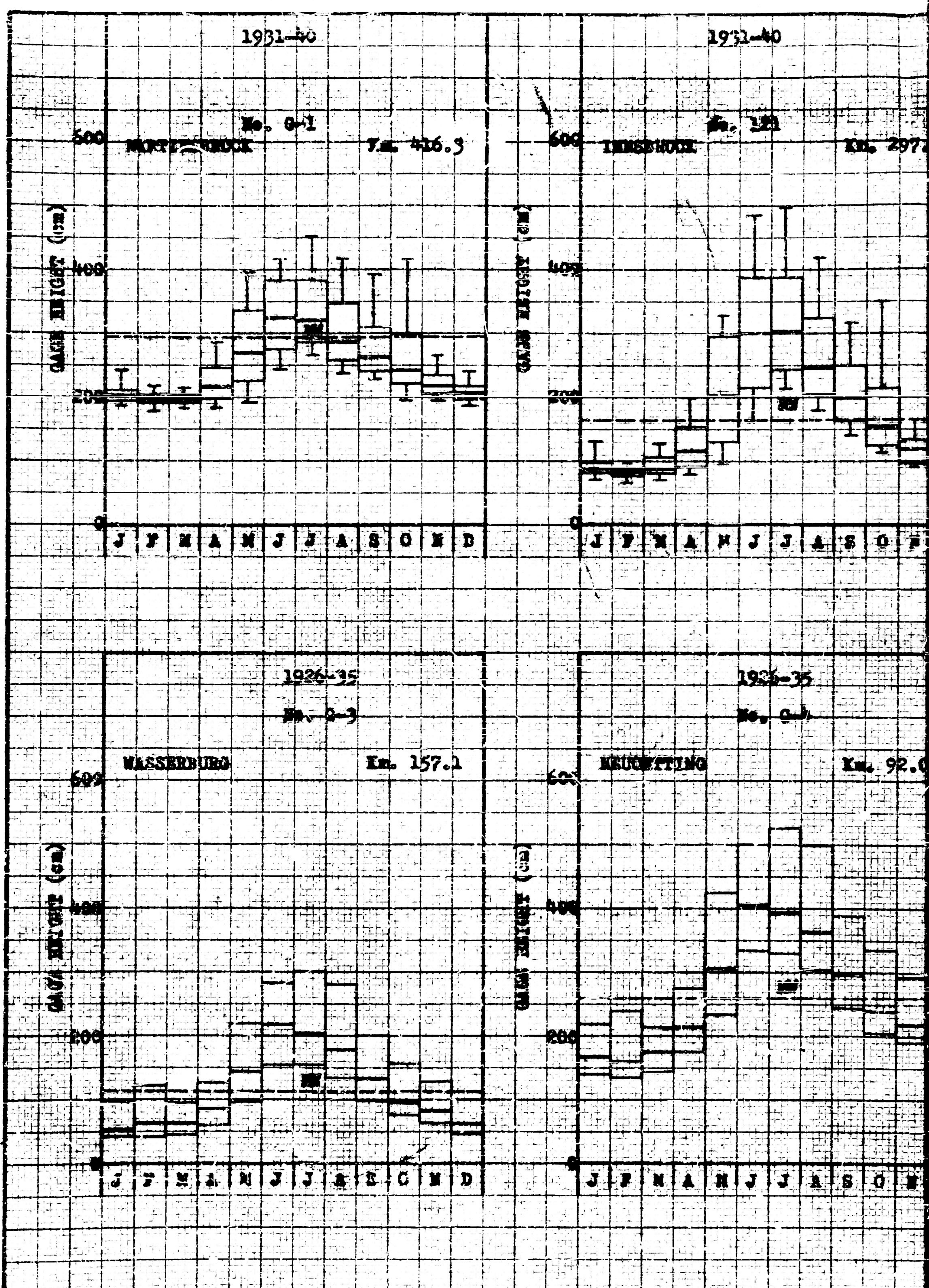


AUSTRIAN ALPS

MEAN MONTHLY PRECIPITATION

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by FBB Date Nov. 1953
Drawn by [illegible]



1931-40
No. G-1
Km. 416.3
GAGE HEIGHT (cm)
600
400
200
0
MW
J F M A M J J A S O N D
1931-40
600
400
200
0
MW
J F M A M J J A S O
1926-35
No. G-3
WASSERBURG
Km. 157.1
GAGE HEIGHT (cm)
600
400
200
0
MW
J F M A M J J A S O N D
1926-35
Km. 92.0
600
400
200
0
MW
J F M A M J J A S O

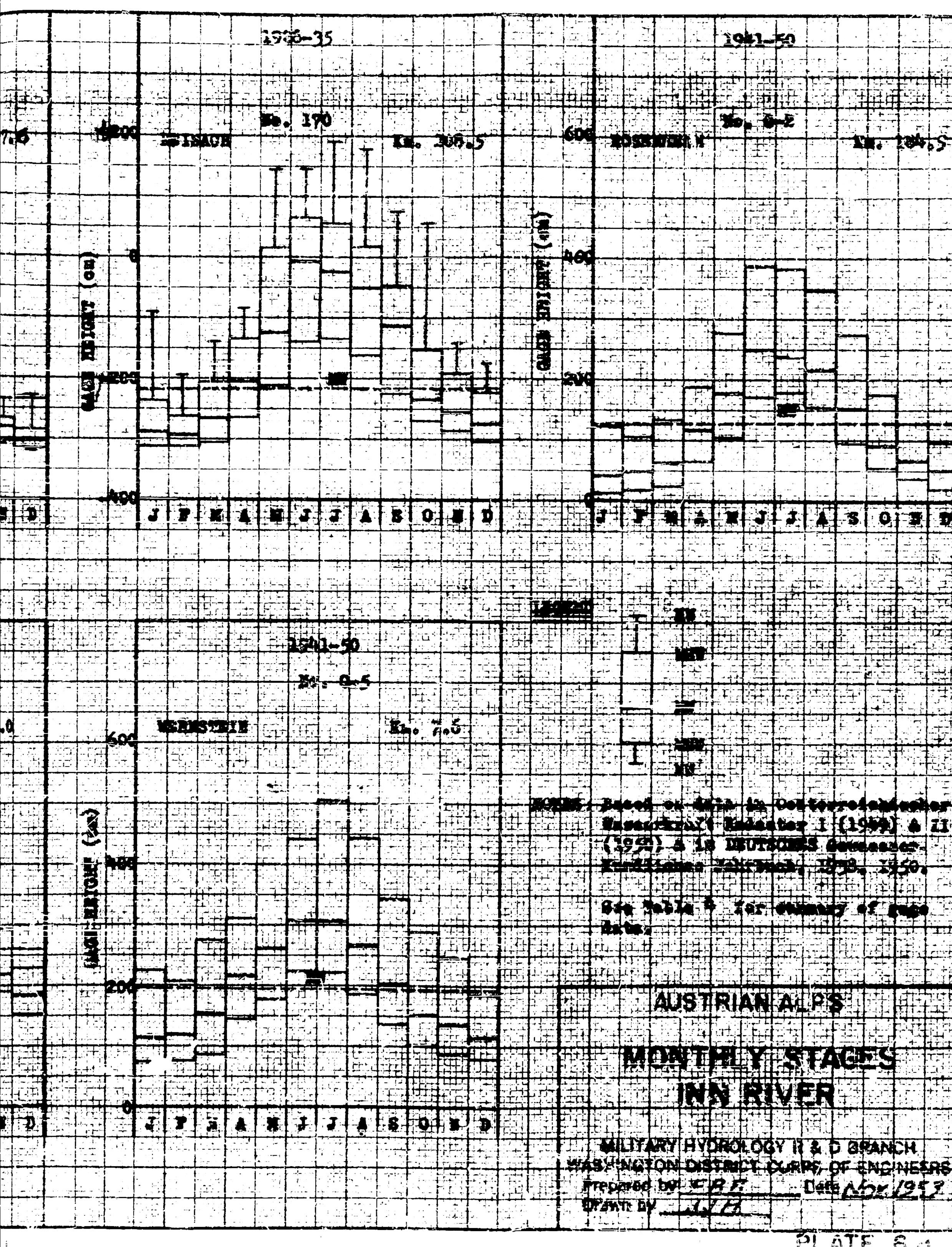
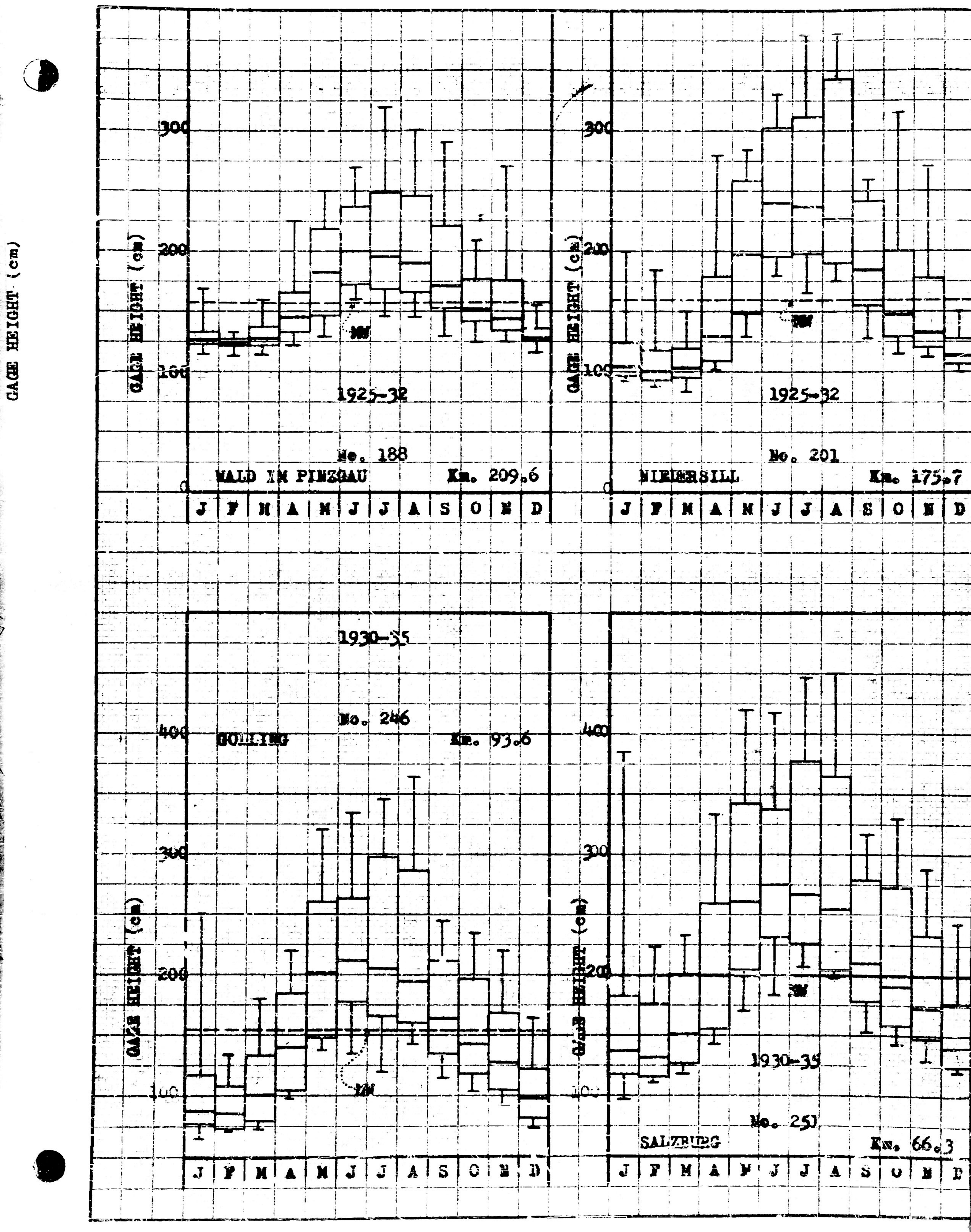
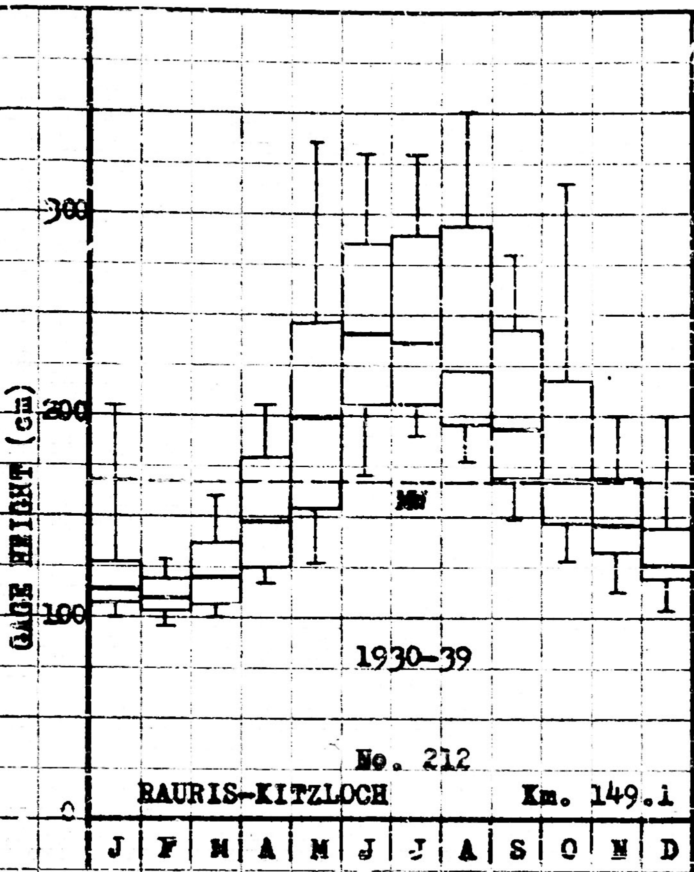
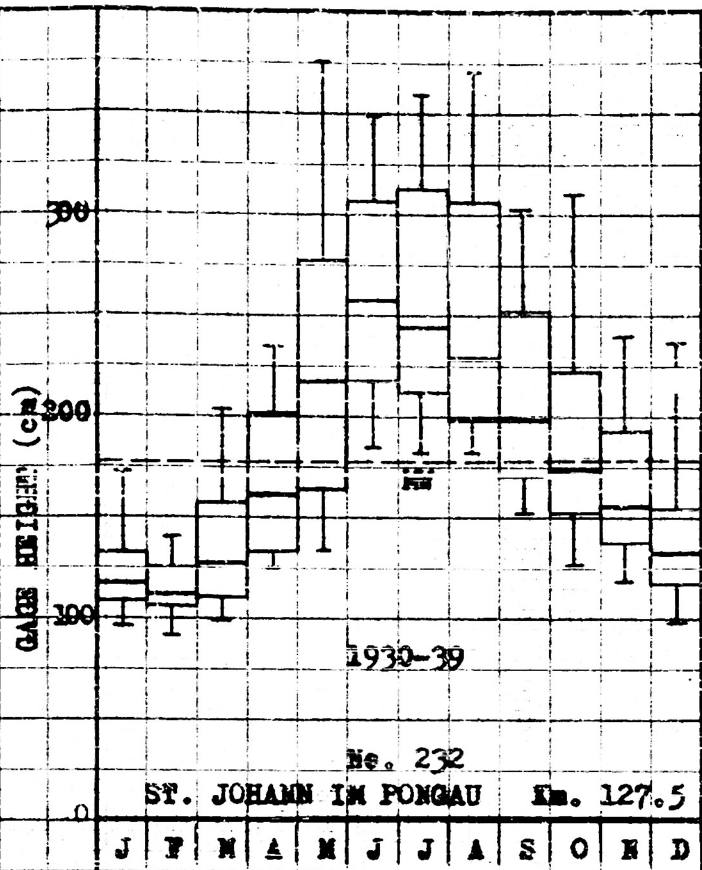
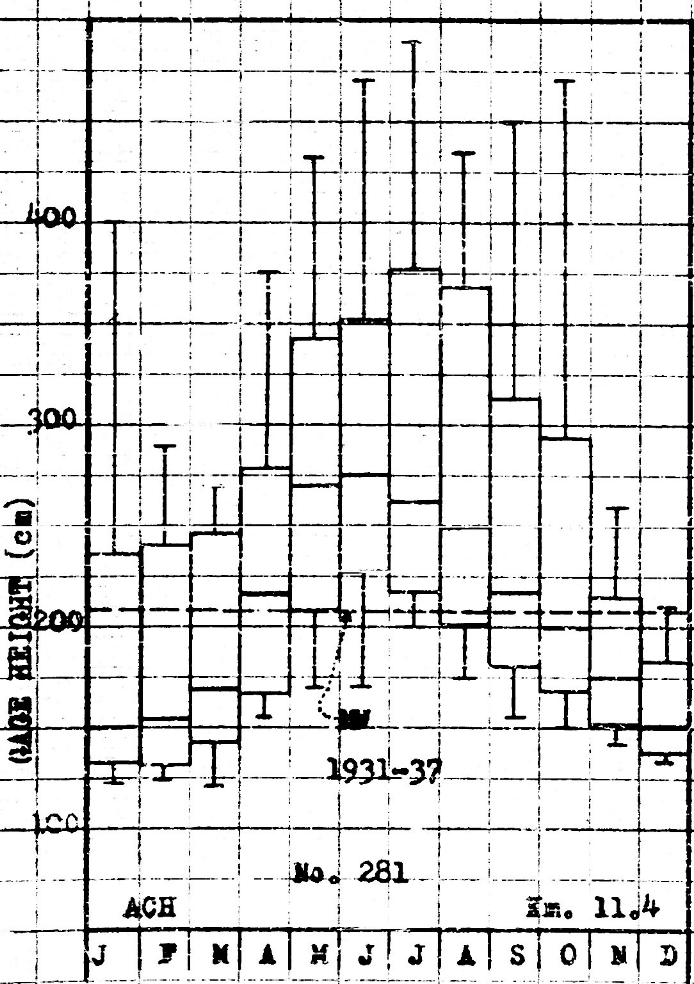

1941-50
No. 170
600
400
200
0
GAGE HEIGHT (cm)
MW
J F M A M J J A S O N D
1941-50
LEGEND
AUSTRIAN ALPS
MONTHLY STAGES
INN RIVER
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by
Date
Drawn by

PLATE 6

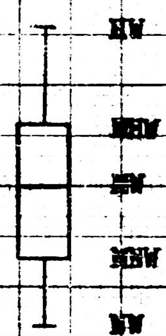

GAGE HEIGHT (cm)
1925-32
No. 188
WALD IM PINZGAU
Km. 209.6
MW
J F M A M J J A S O N D
1925-32
No. 201
NIEDERSILL
Km. 175.7
MW
J F M A M J J A S O N D
1930-35
No. 246
GOLLING
Km. 93.6
MW
J F M A M J J A S O N D
1930-35
No. 251
SALZBURG
Km. 66.3
MW
J F M A M J J A S O N D







LEGEND



NOTES: Based on data in Oesterreichischer Wasserkraft Kadaster SALZACH I (1950) & II (1948)
See Table 4 for summary of gage data.

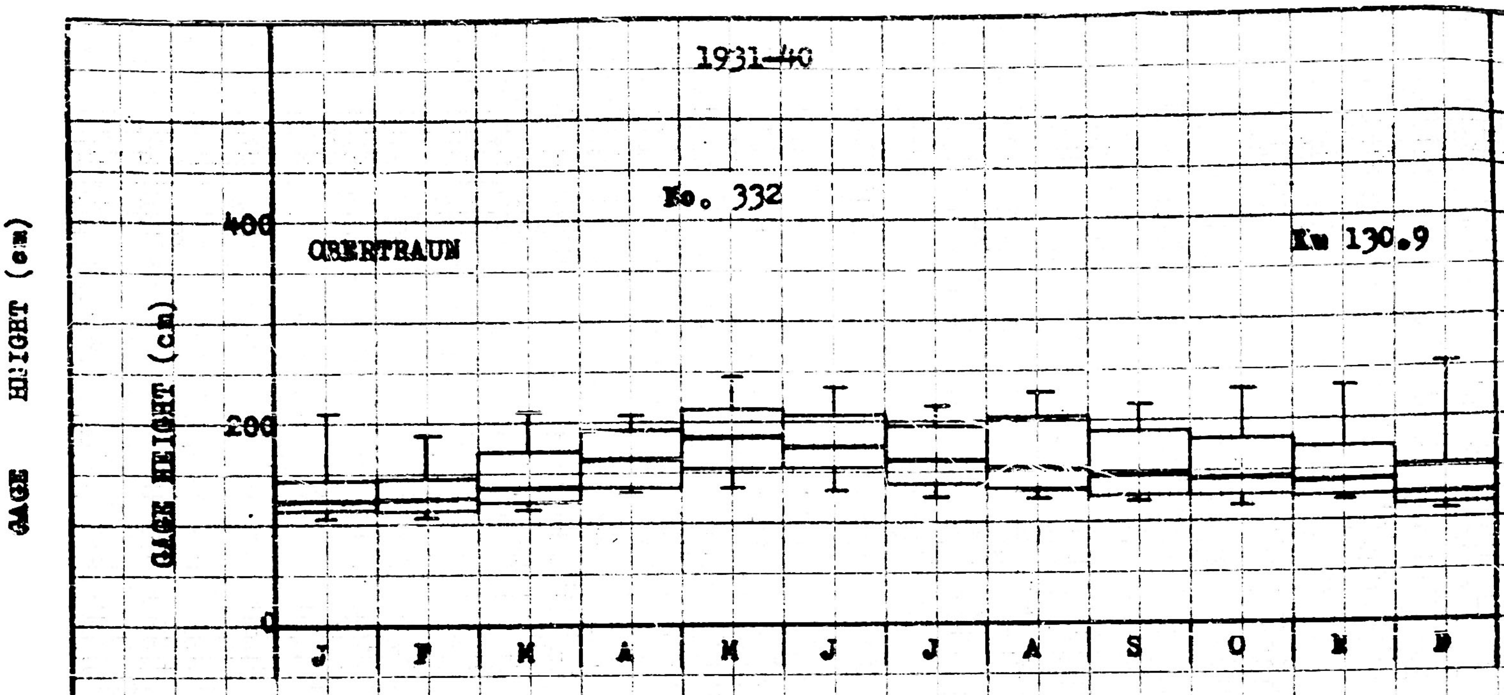
AUSTRIAN ALPS

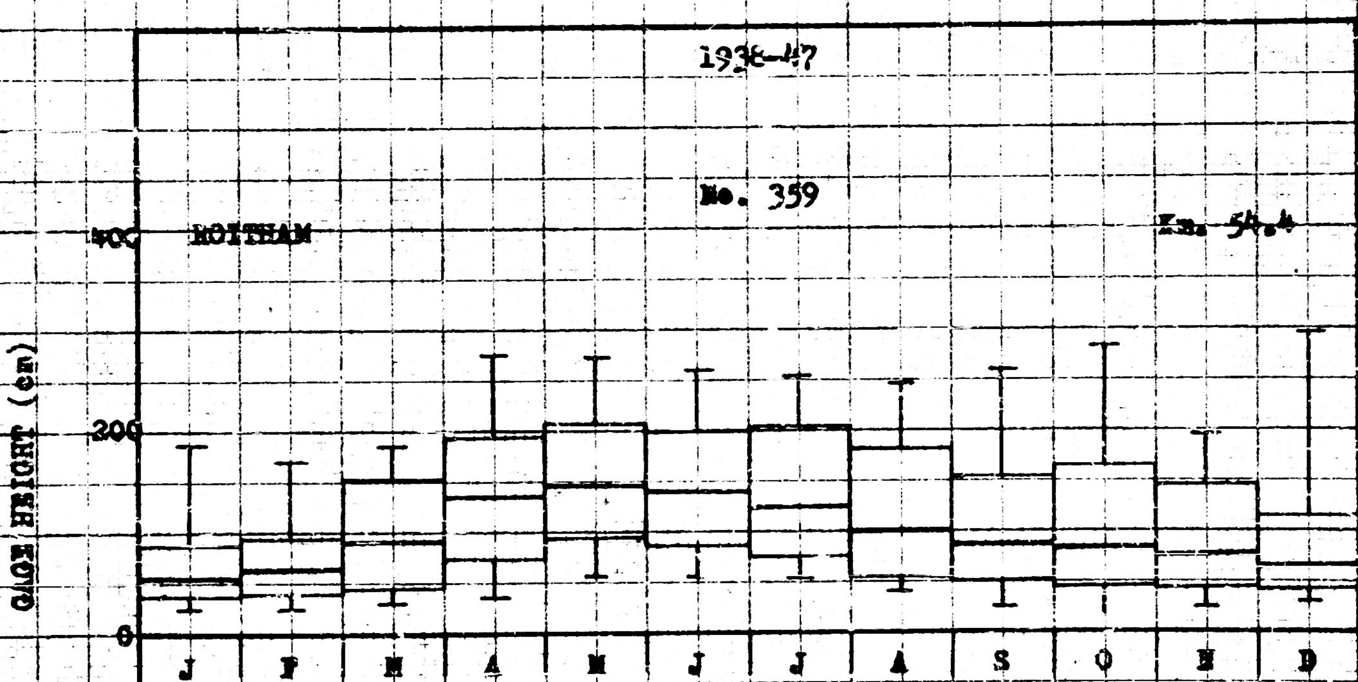
MONTHLY STAGES SALZACH RIVER

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by *FBB* Date *Nov. 1953*
Drawn by *JJH*

PLATE 66

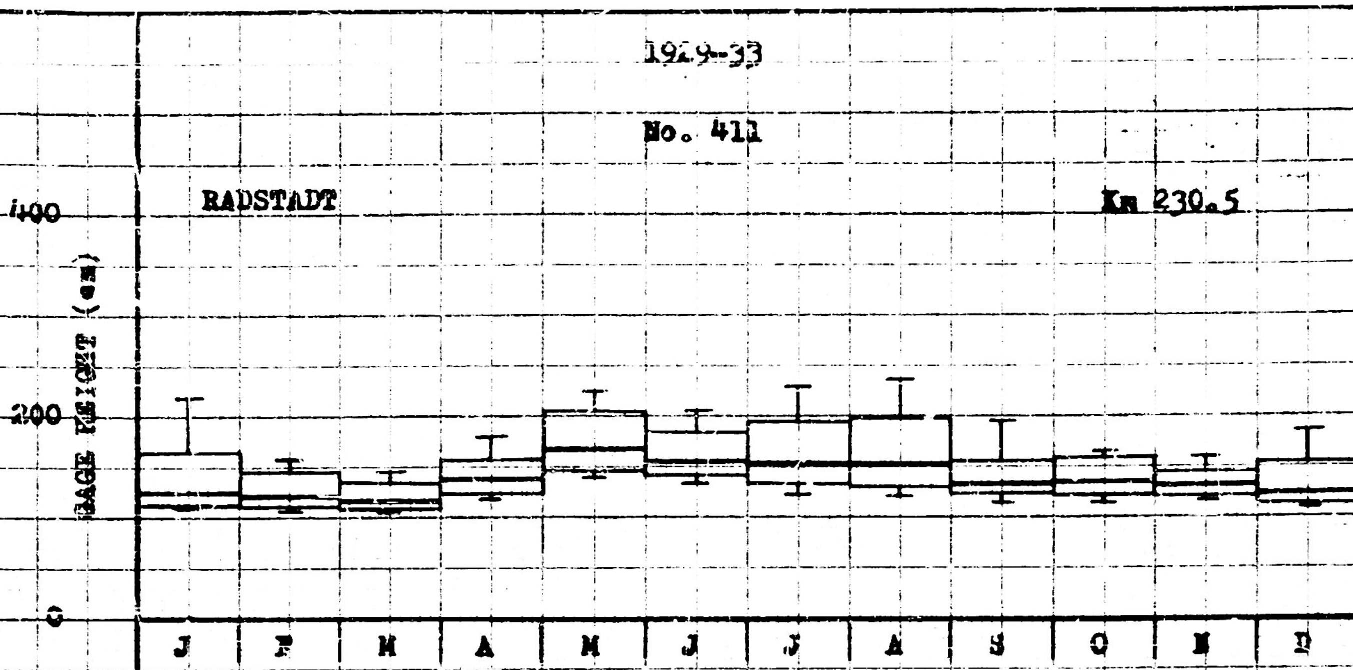


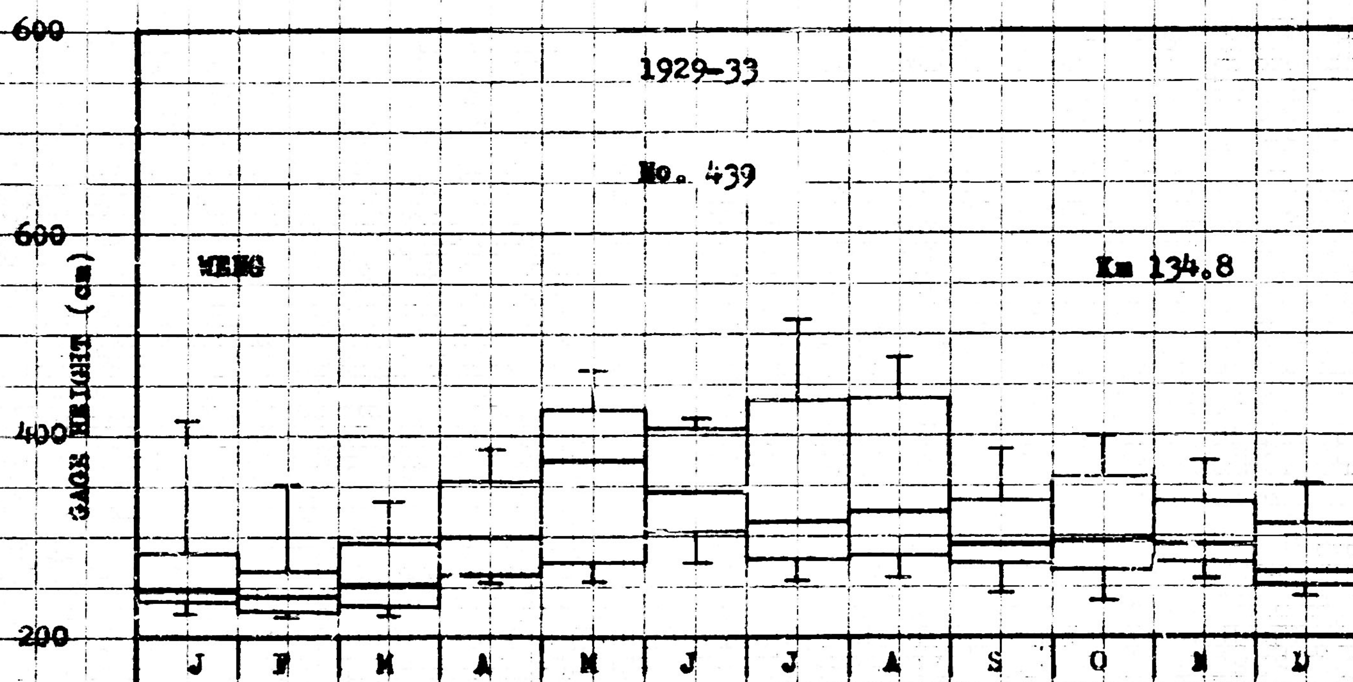


NOTE.

Based on data in Oesterreichischer Wasserkraft-Traun, 1949.

See Table 4 for summary of gage data.



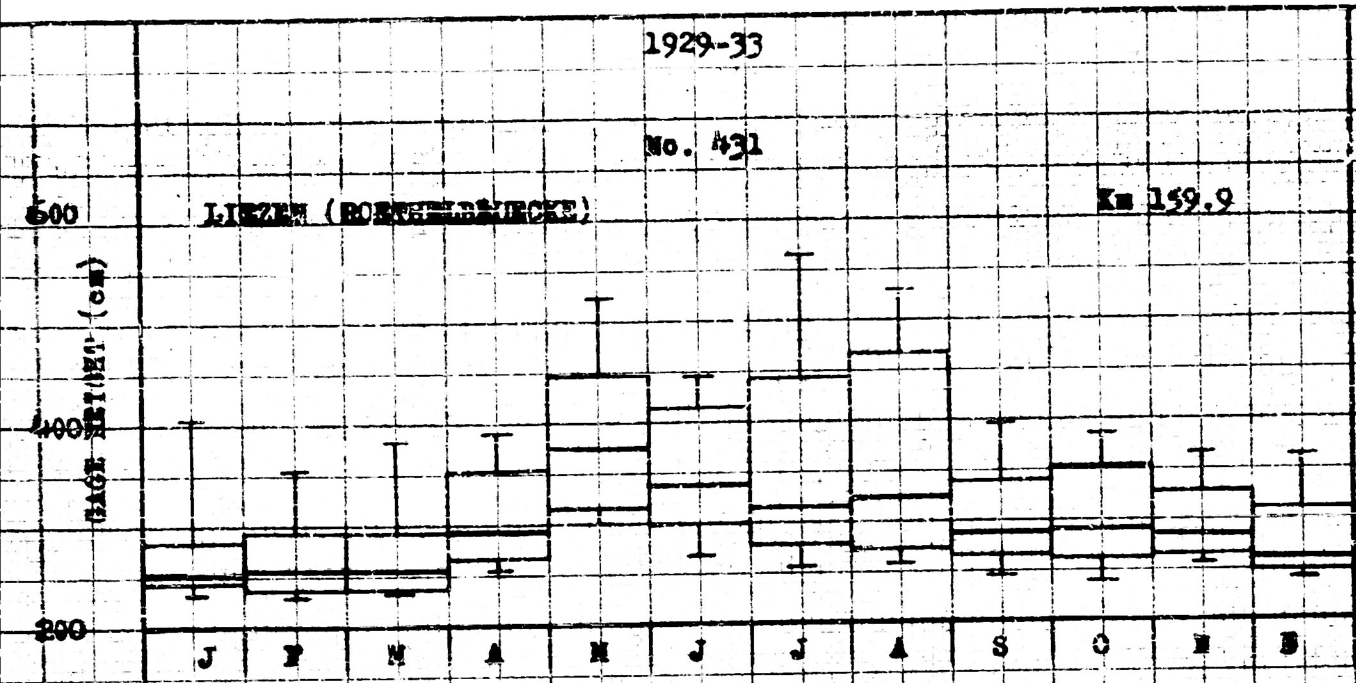


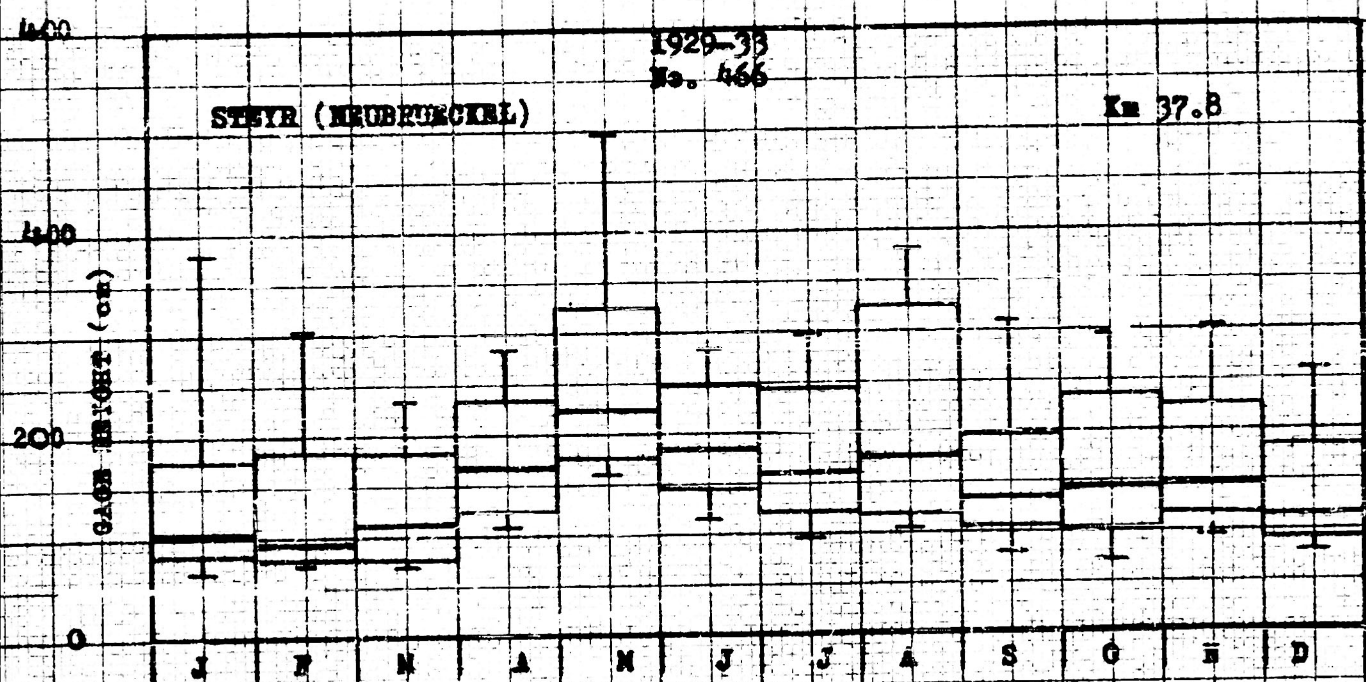
LEG

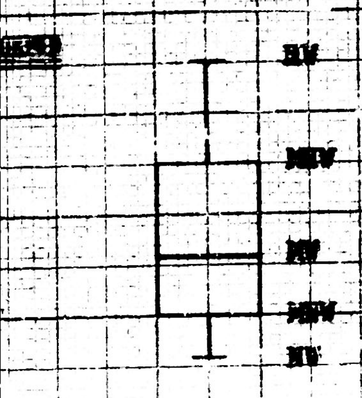
NOTE.

Based on Oesterreichischer Kadaster-Enns

See Table 4 for summary of gage data.







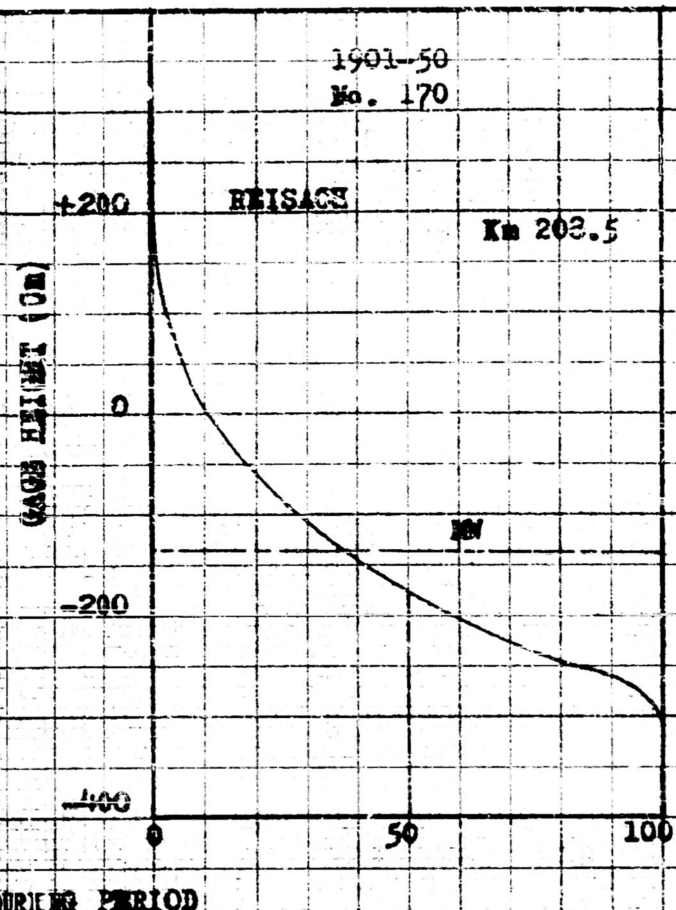
AUSTRIAN ALPS

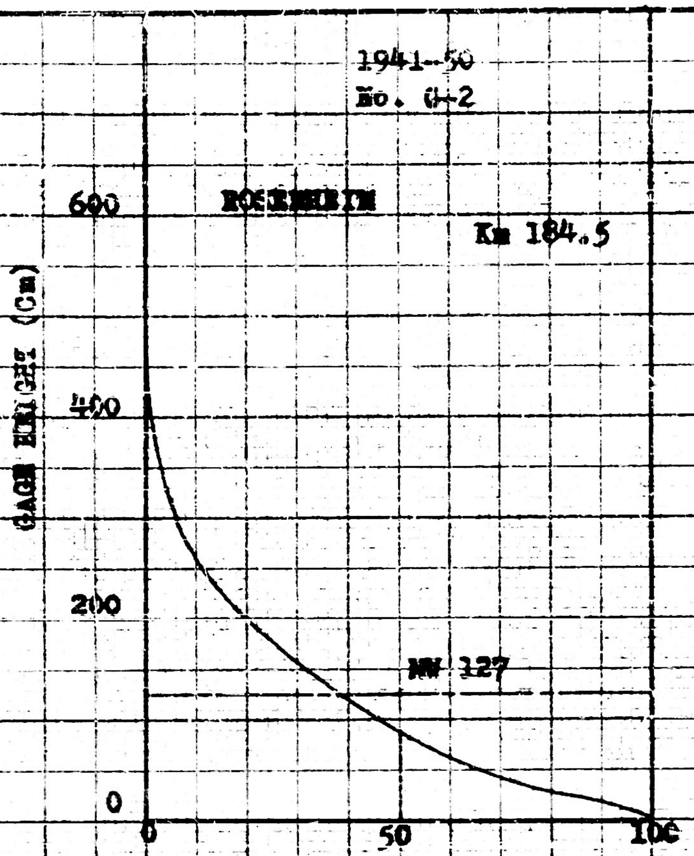
MONTHLY STAGES
ENNS RIVER

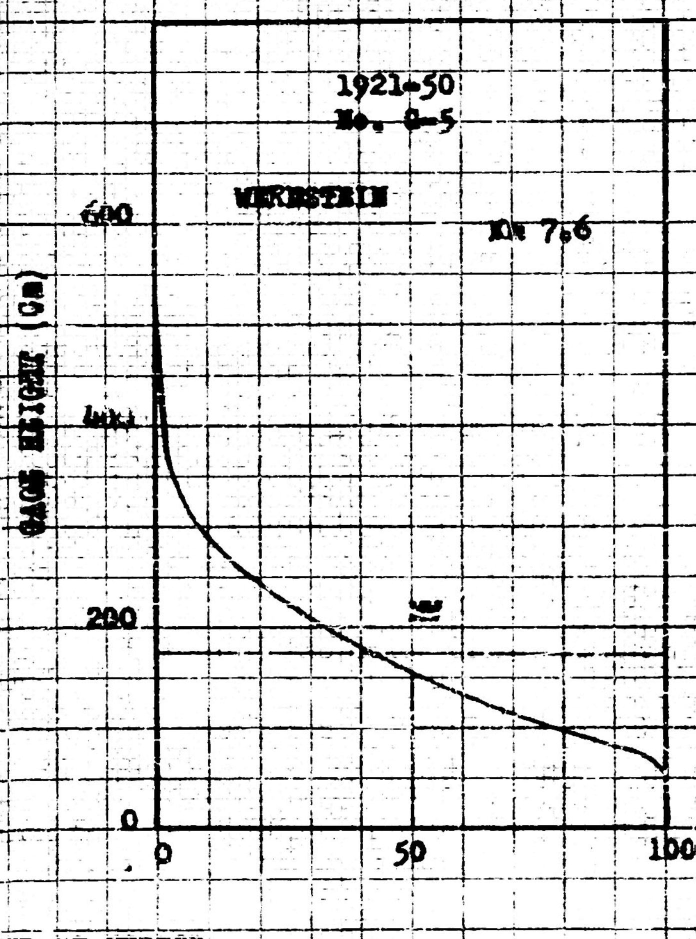
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by *E.R.E.* Date *NOV. 1953*
Drawn by *J.J.H.*

PLATE 6 d







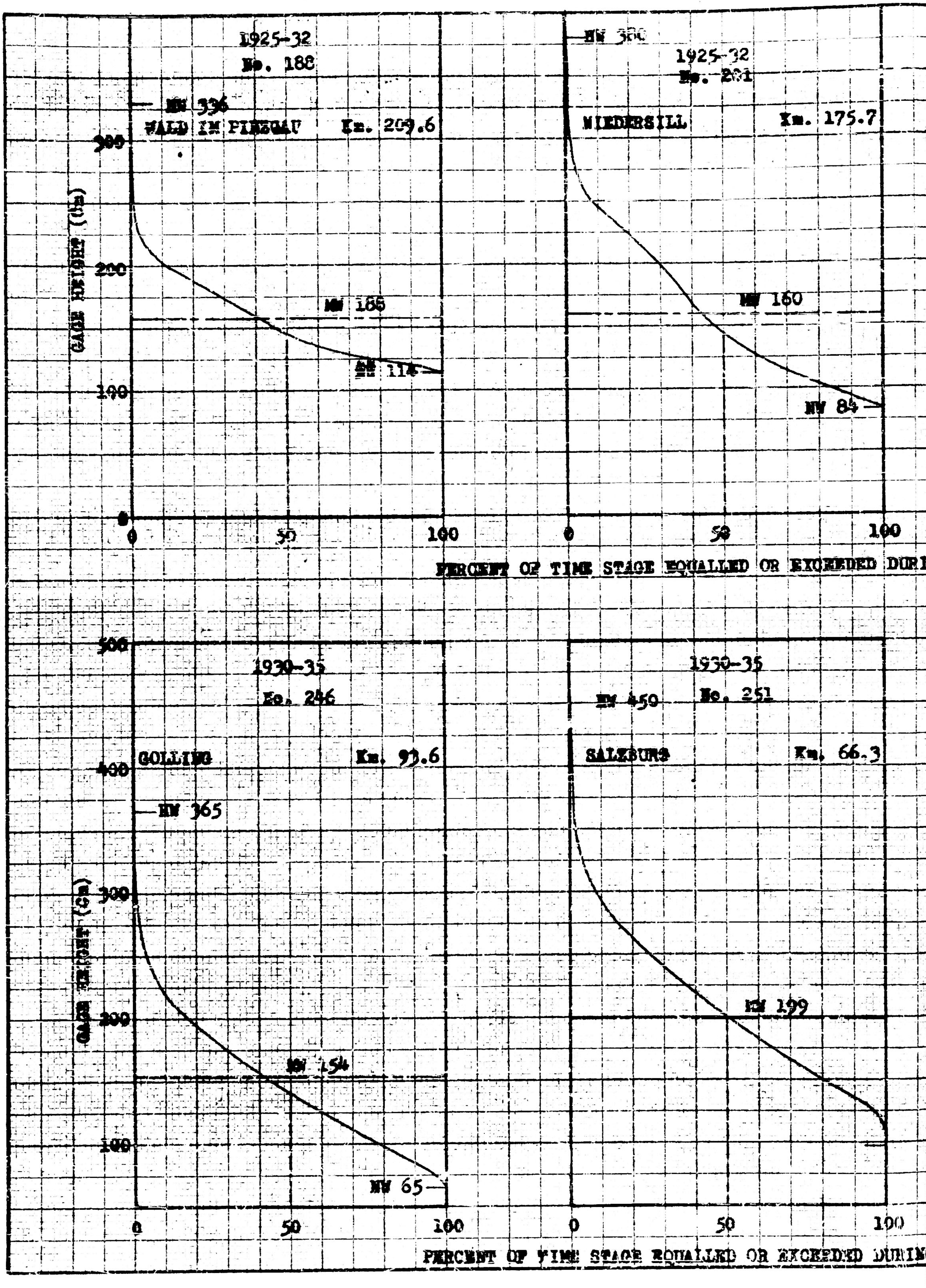
NOTES: Based on data in Oesterreichischer Wasserkraft Kadaster I (1949) & II (1950) & in DEUTSCHES Gewässer-Kundliches Jahrbuch, 1938, 1950.

See Table 4 for summary of gage data.

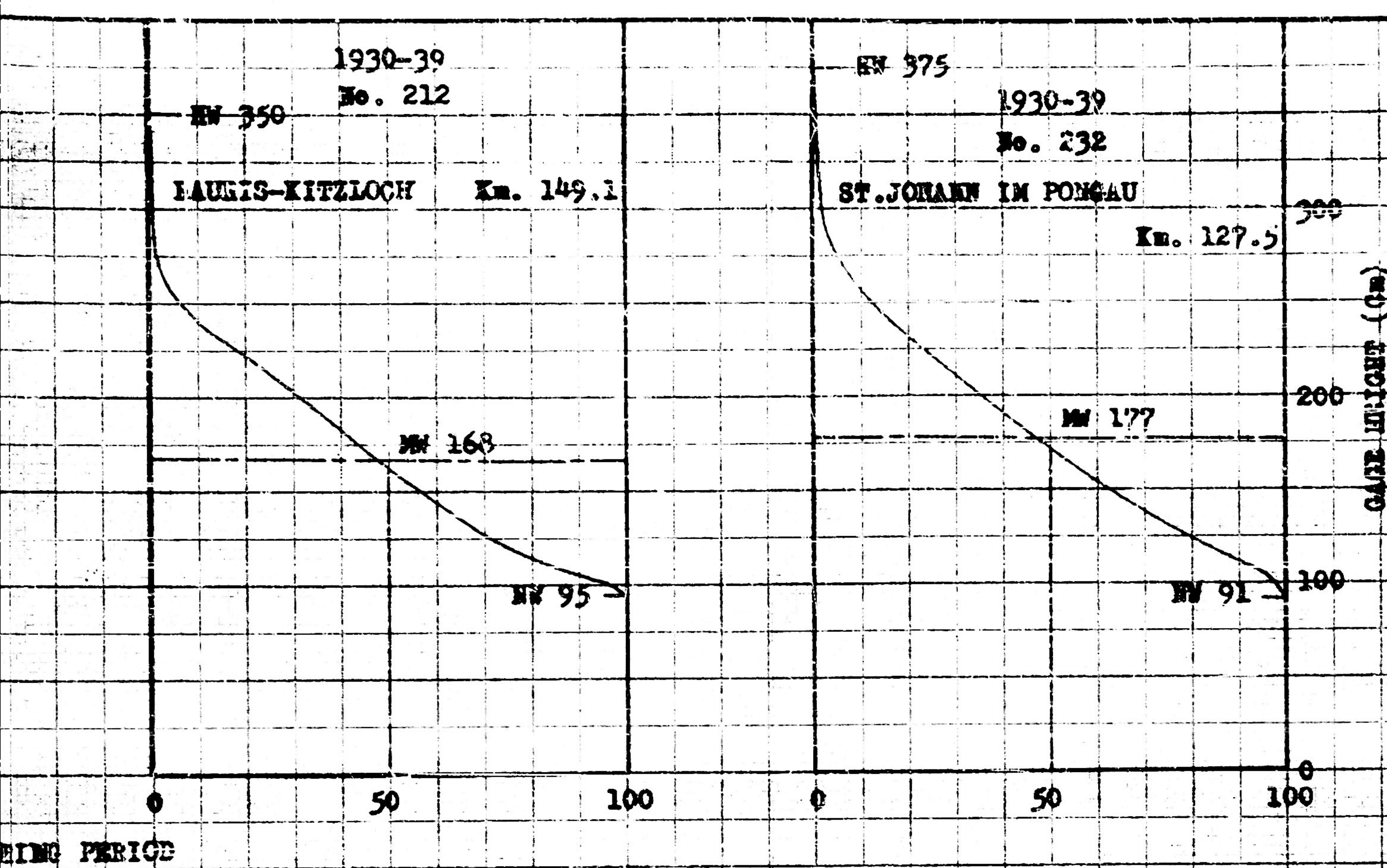
AUSTRIAN ALPS

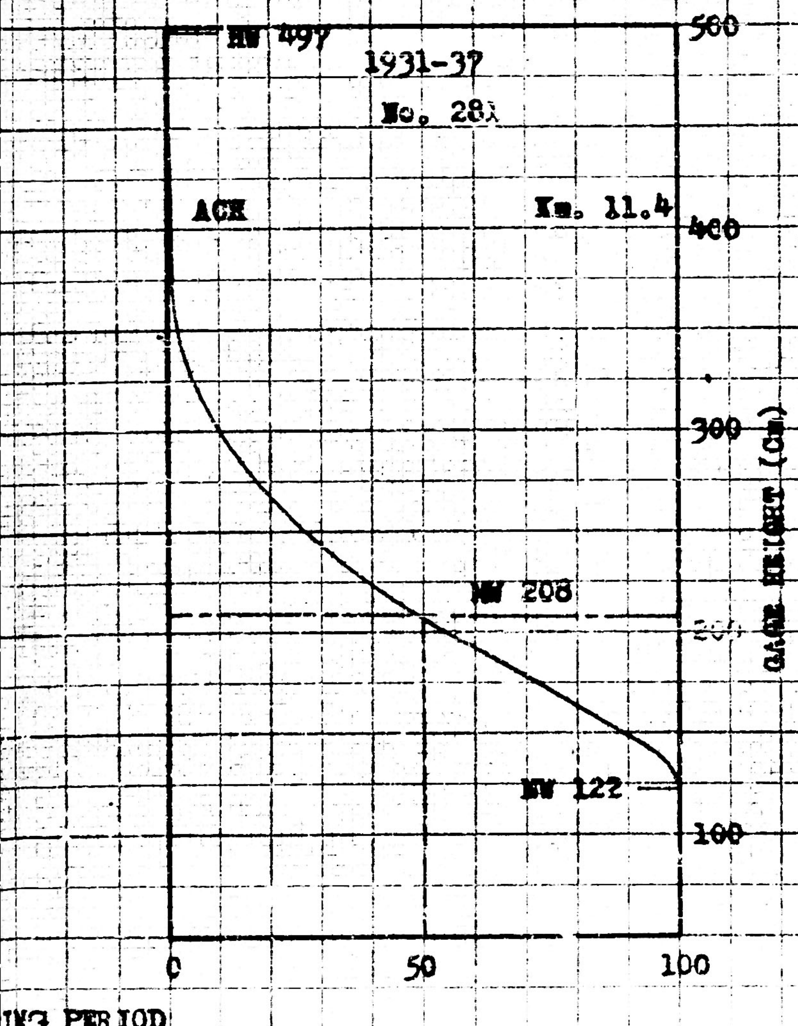
STAGE DURATION CURVES INN RIVER

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by FBB Date Nov. 1953
Drawn by J.I.H.



1925-32
No. 188
HW 336
WALD IM PINZGAU
Km. 209.6
MW 185
NW 114
GAGE HEIGHT (Cm)
300
200
100
0
1925-32
NIEDERSILL
Km. 175.7
MW 160
NW 84
0
50
100
0
50
100
PERCENT OF TIME STAGE EQUALLED OR EXCEEDED DURI
1930-35
No. 246
GOLLING
Km. 93.6
HW 365
MW 154
NW 65
GAGE HEIGHT (Cm)
500
400
300
200
100
1930-35
No. 251
HW 450
SALZBURG
Km. 66.3
MW 199
0
50
100
0
50
100
PERCENT OF TIME STAGE EQUALLED OR EXCEEDED DURING





NOTES:

Based on data in Oesterreichischer Wasserkraft SALZACH I (1950) & II (1948).

See Table 4 for summary of Gage Data.

AUSTRIAN ALPS

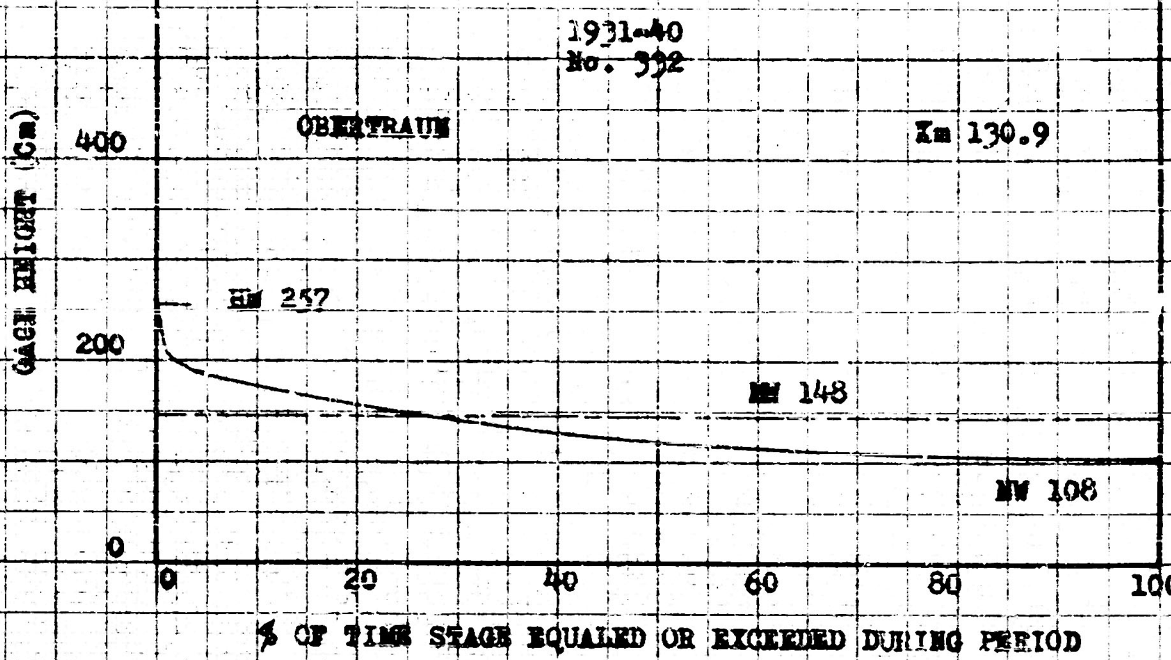
STAGE DURATION CURVES
SALZACH RIVER

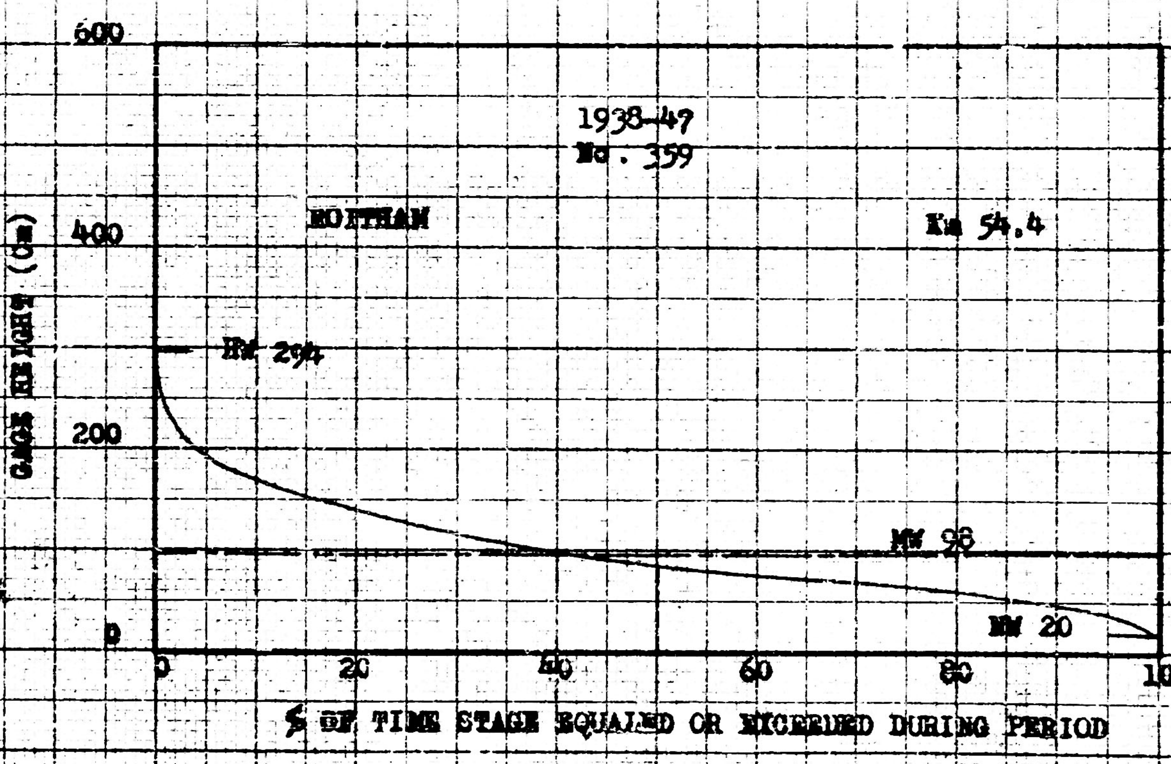
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by EBB Date Nov. 1952

Drawn by JJH

PLATE 7 b

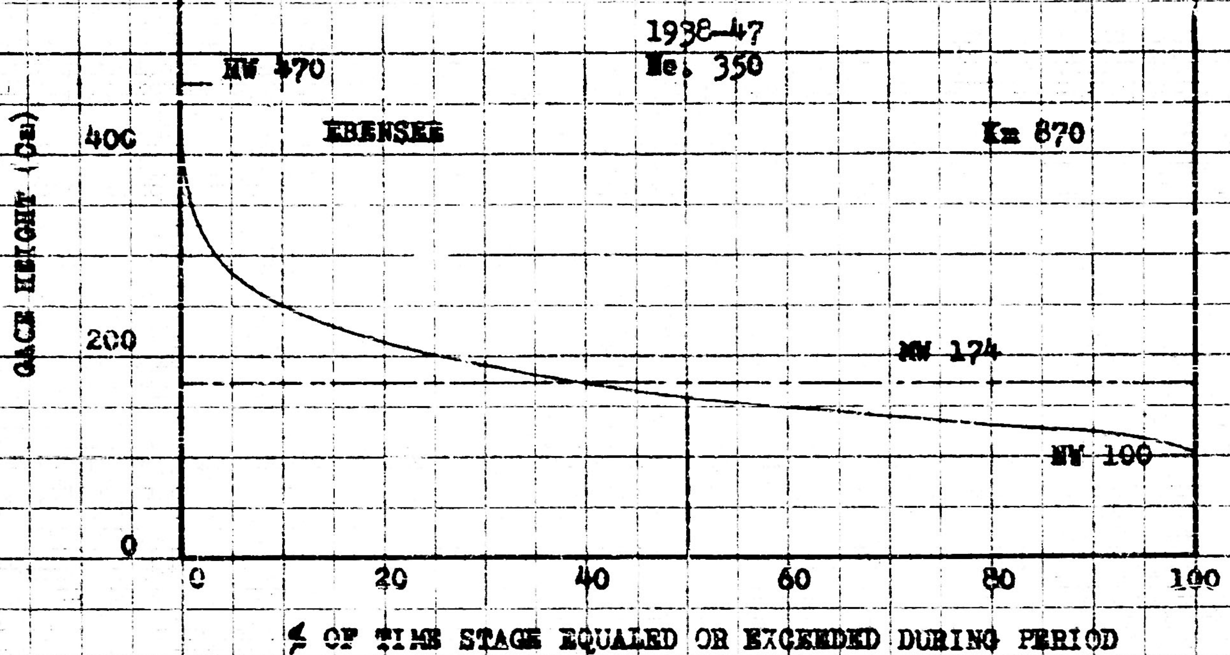


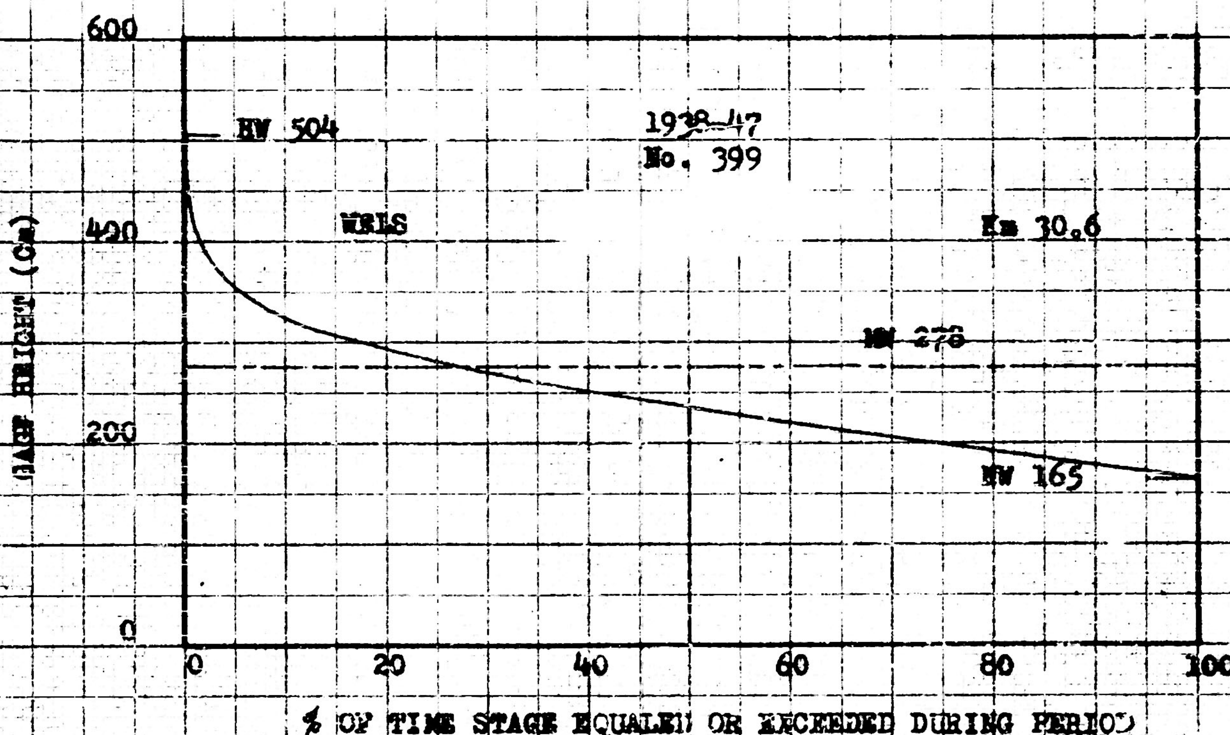


NOTES:

Based on data in Oesterreicher Wasserkraft Kadaster TRA

See Table 4 for summary of gage data.





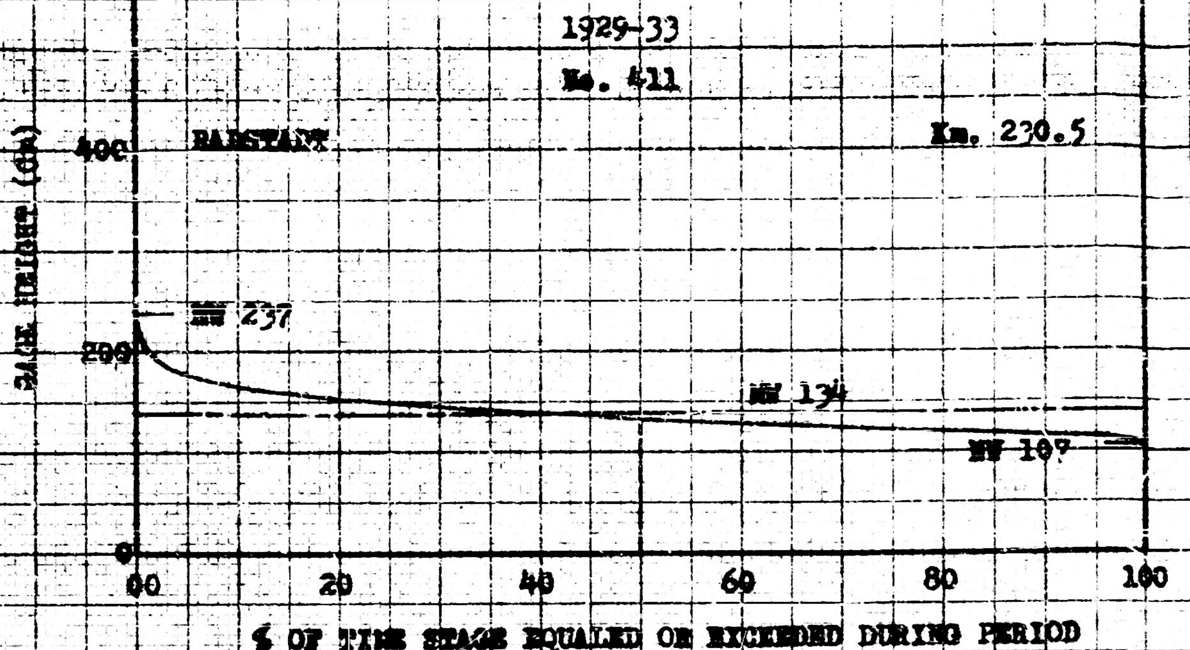
1949

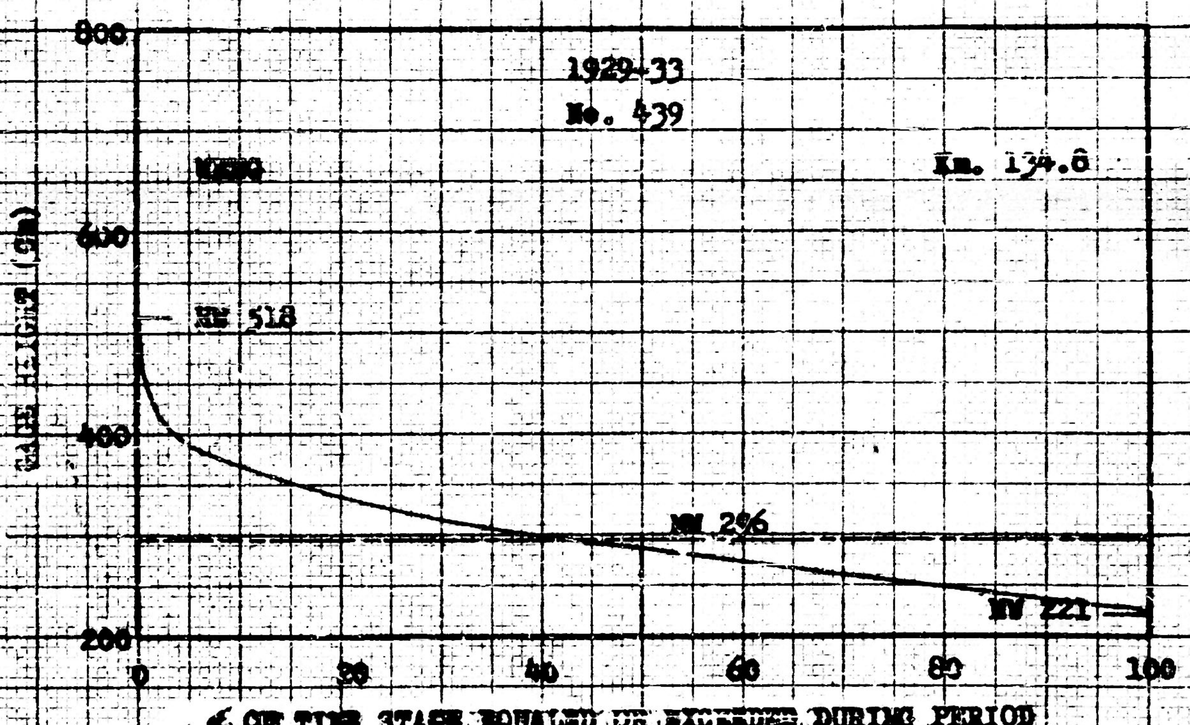
AUSTRIAN ALPS

STAGE DURATION CURVES
TRAUN RIVER

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by FBB Date Nov. 1953
Drawn by JJK

PLATE 7c

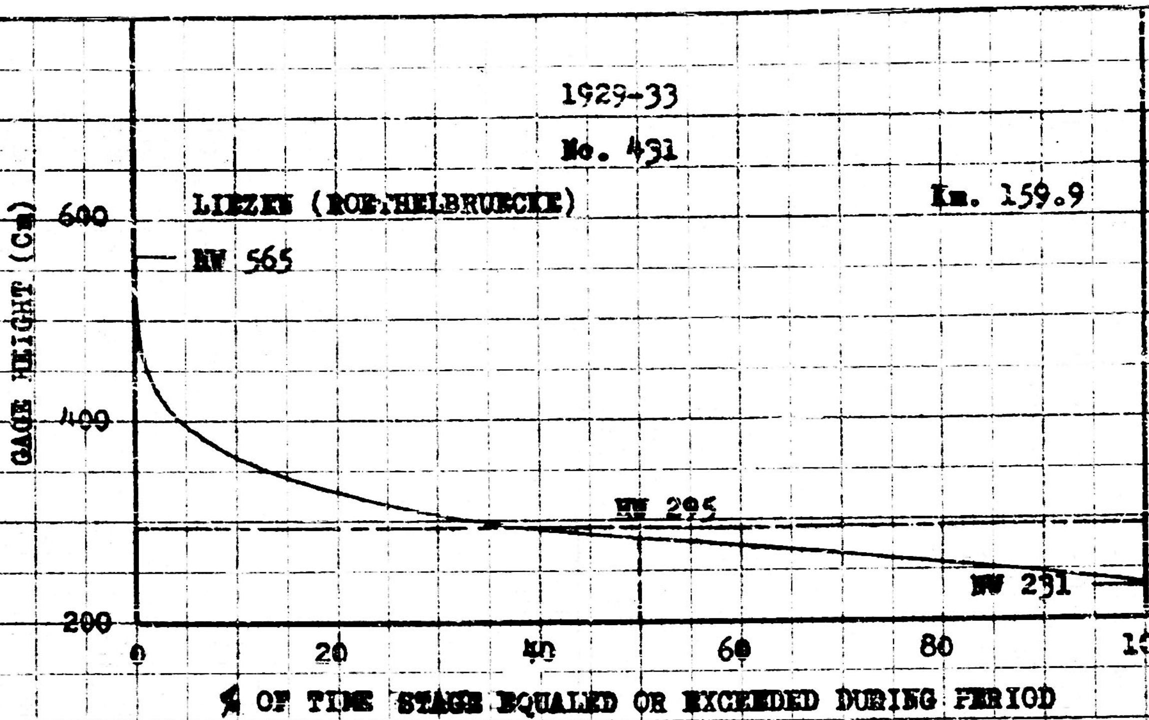


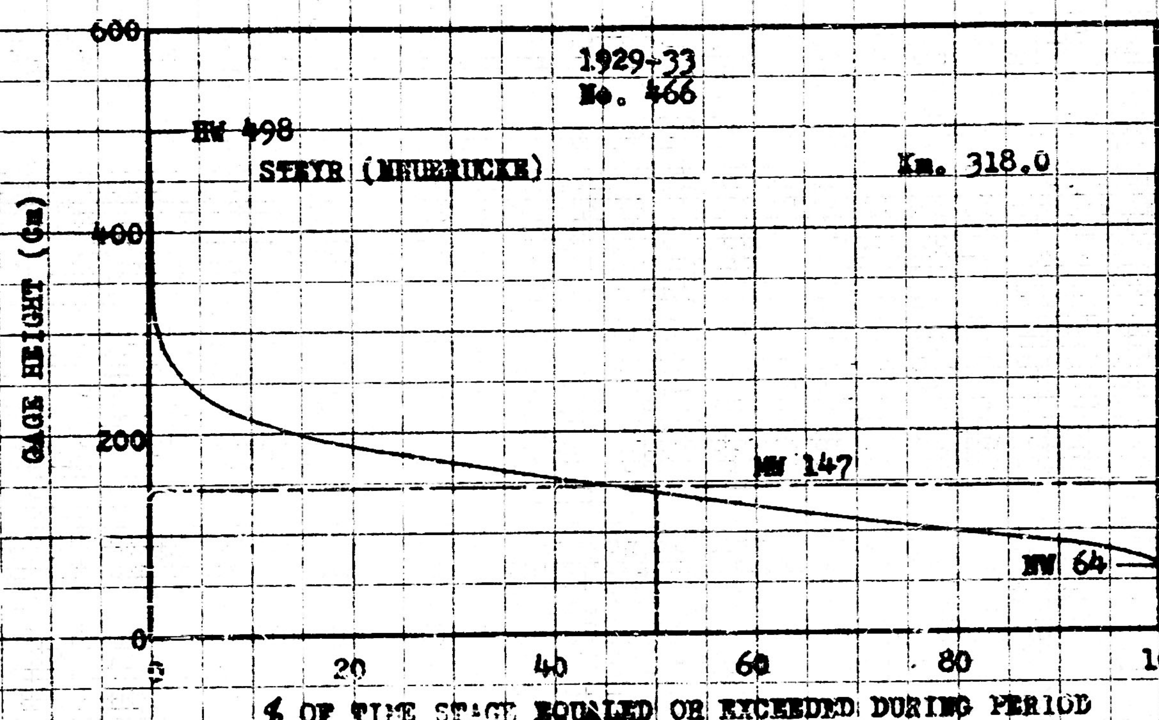


NOTES:

Based on data in Oesterreichischer Wasserkraft Kadaster.

See Table 4 for summary of gage data.



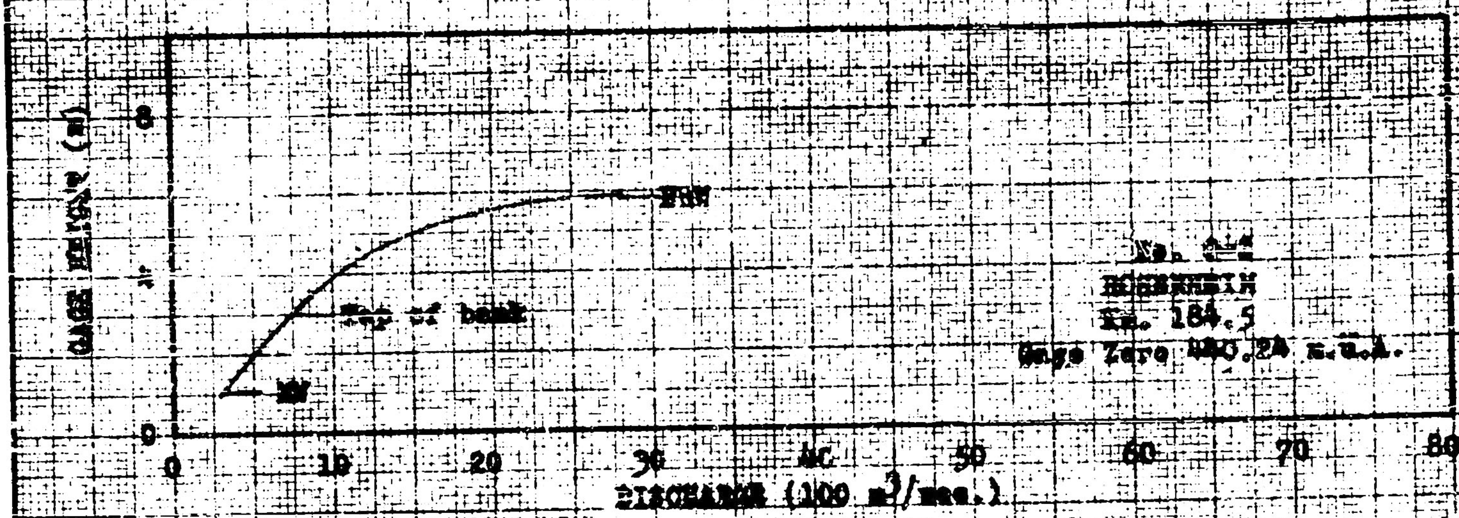


8. 1950.

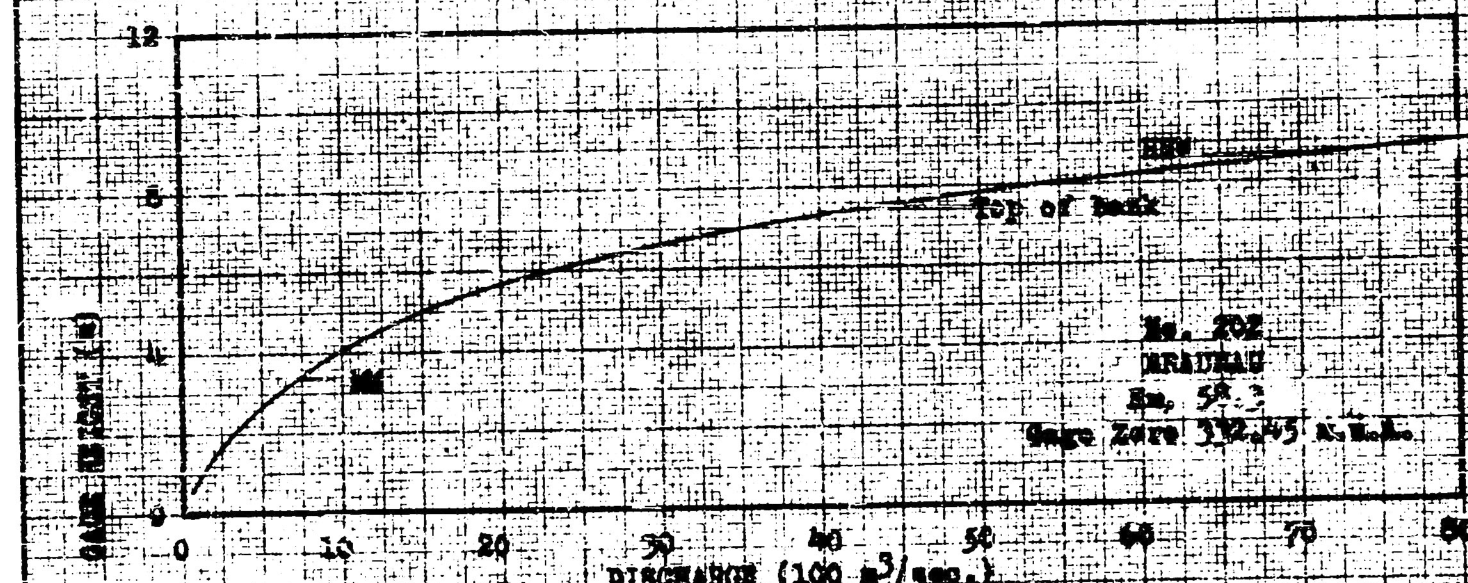
AUSTRIAN ALPS

STAGE DURATION CURVES
ENNS RIVER

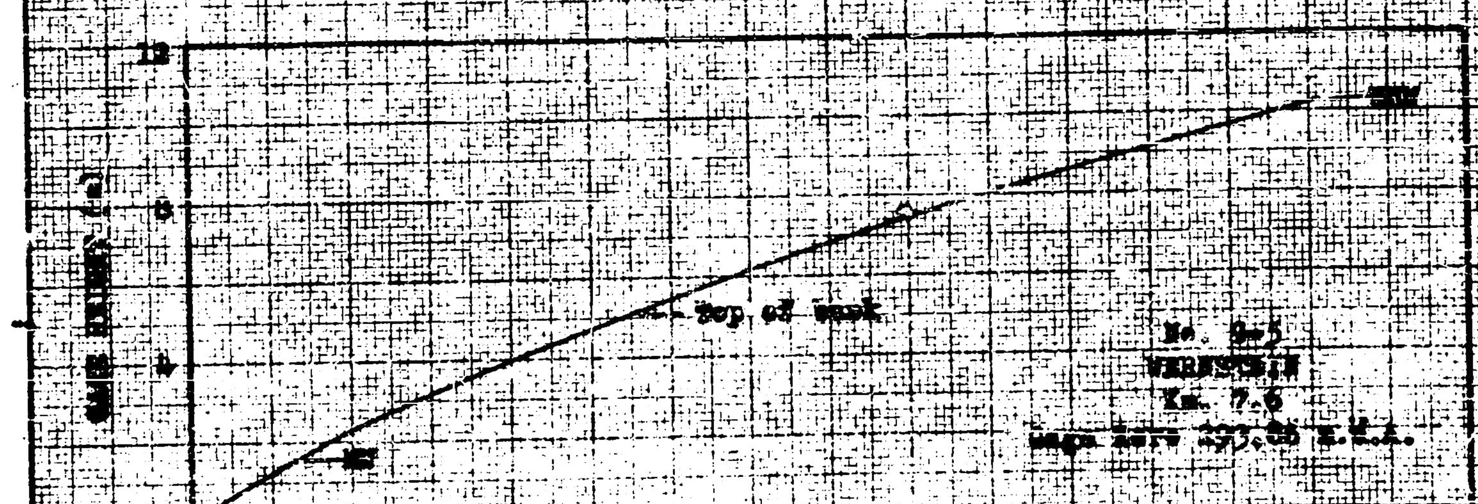
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by EBB Date Nov. 1953
Drawn by JJH



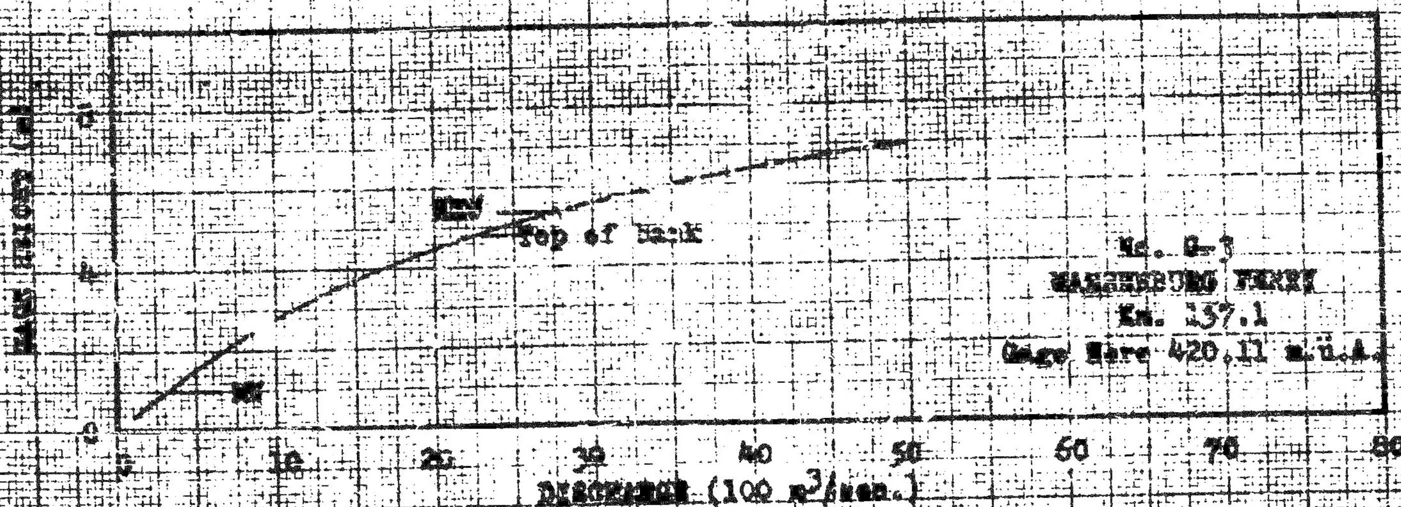
GAGE HEIGHT (m)
HHW
Top of bank
MW
Km. 184.5
DISCHARGE (100 m3/sec.)

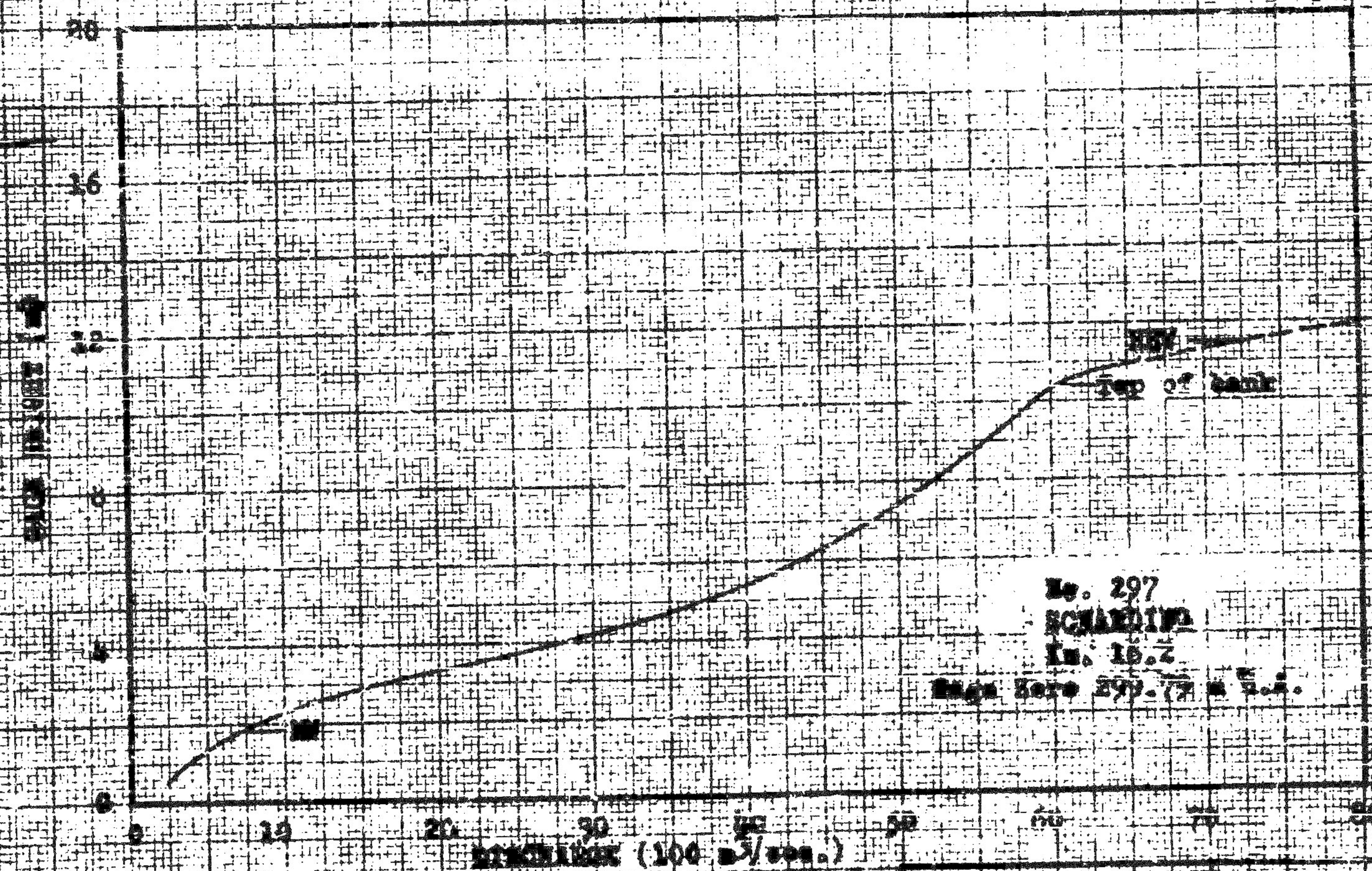


HHW
Top of bank
MW
No. 202
Gage Zero
DISCHARGE (100 m3/sec.)



HHW
Top of bank
MW
Km. 7.6
DISCHARGE (100 m3/sec.)





LEGEND

Limit of Observed Data

Estimated Extension

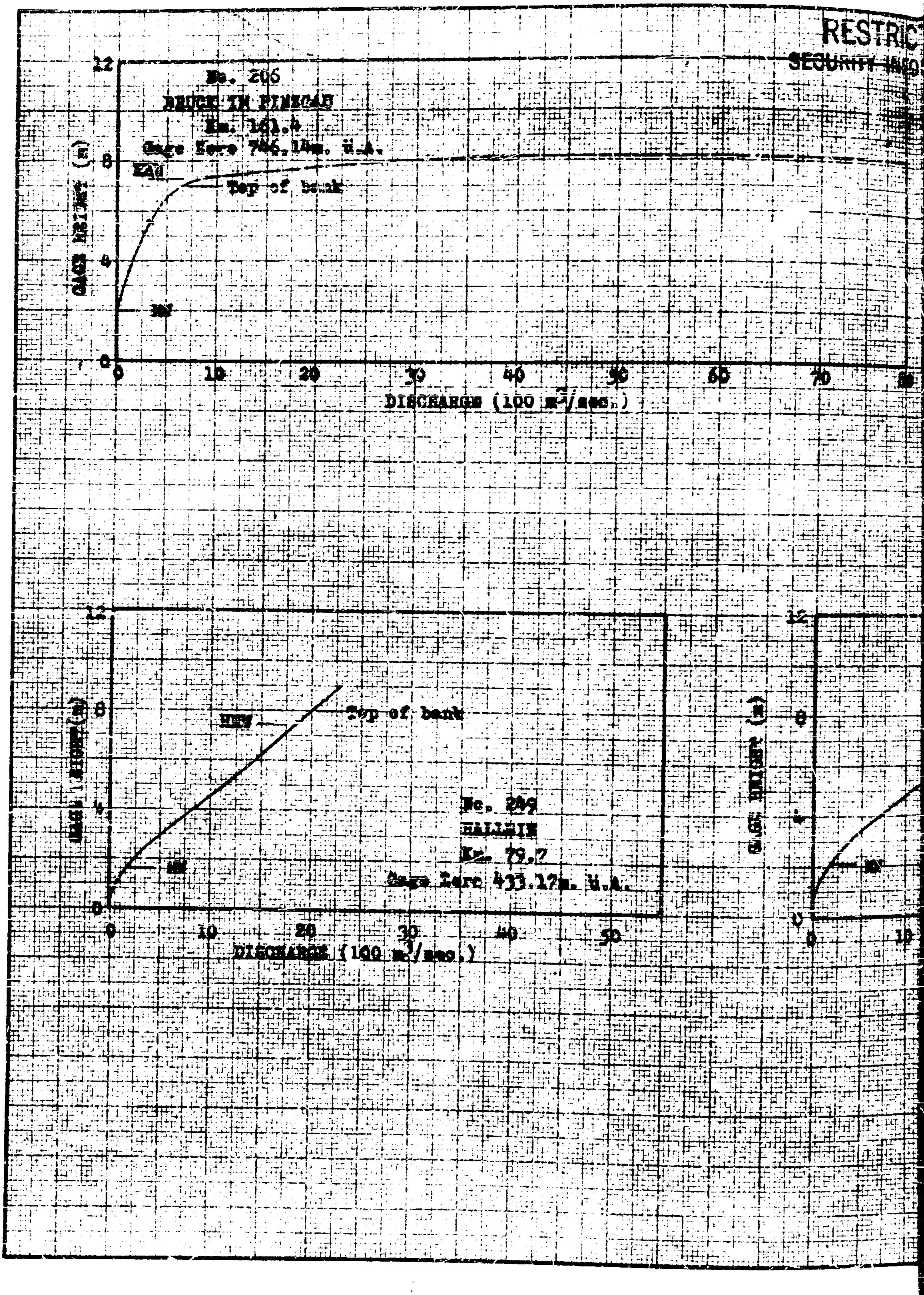
NOTE:- Curves shown are estimated.

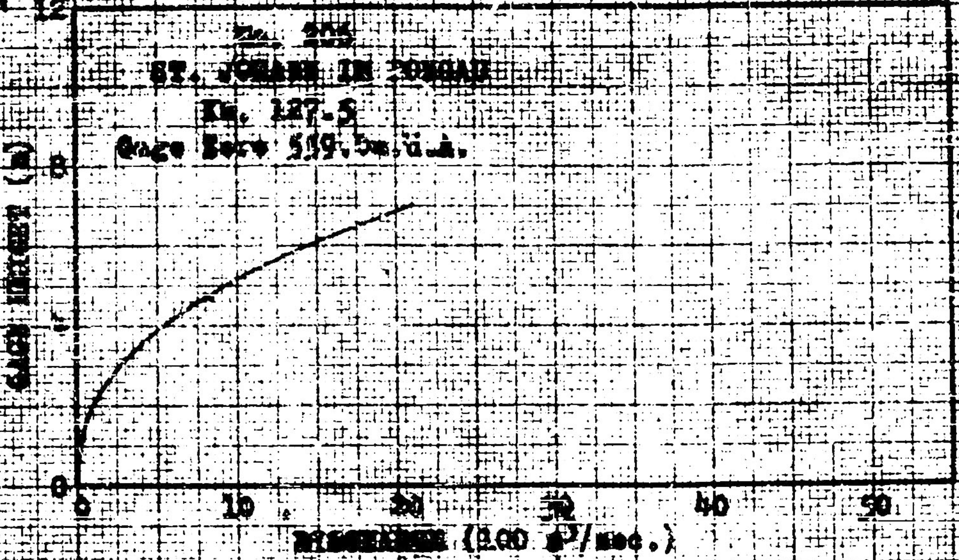
AUSTRIAN ALPS

DISCHARGE RATING CURVES
INN RIVER

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JDB Date Nov 1953
Drawn by LSH

PLATE 8a


206
Top of bank
0
4
8
12
0
10
20
30
40
50
60
70
DISCHARGE (100 m³/sec.)
No. 249
HALLEIN
Km. 79.7
Gage Zero 433.17m. ü.A.
Top of bank
HHW
0
8
12
0
10
20
30
40
50
DISCHARGE (100 m³/sec.)
GAGE HEIGHT (m)
12
8
4
0
0
10

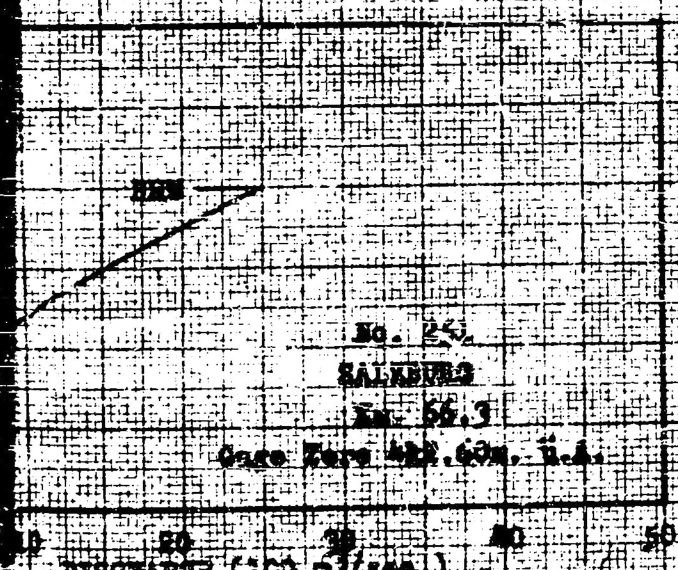


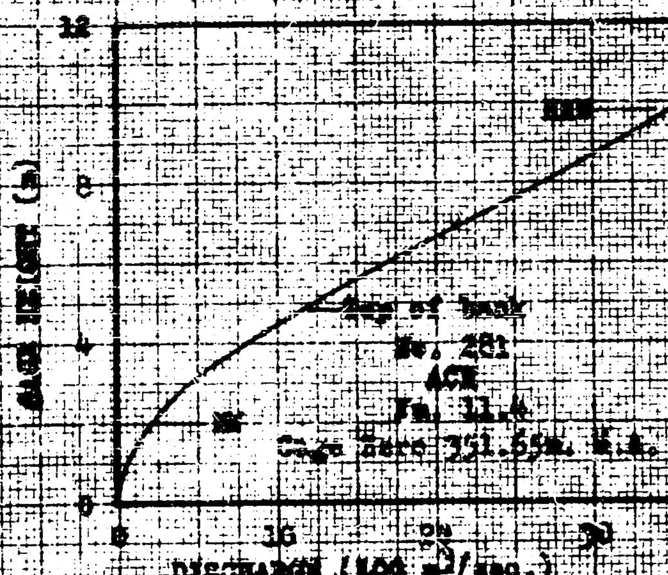
LEGEND

Limit of Observed Data

Estimated Extension

NOTE:
Curves shown are estimated.





AUSTRIAN ALPS

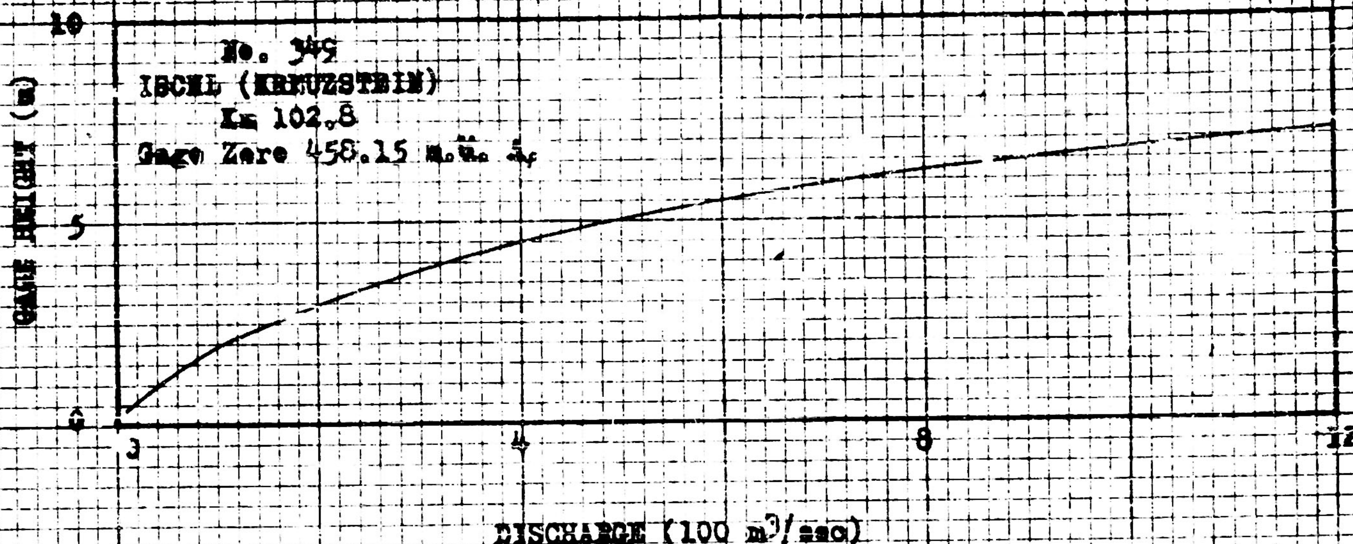
DISCHARGE RATING CURVES

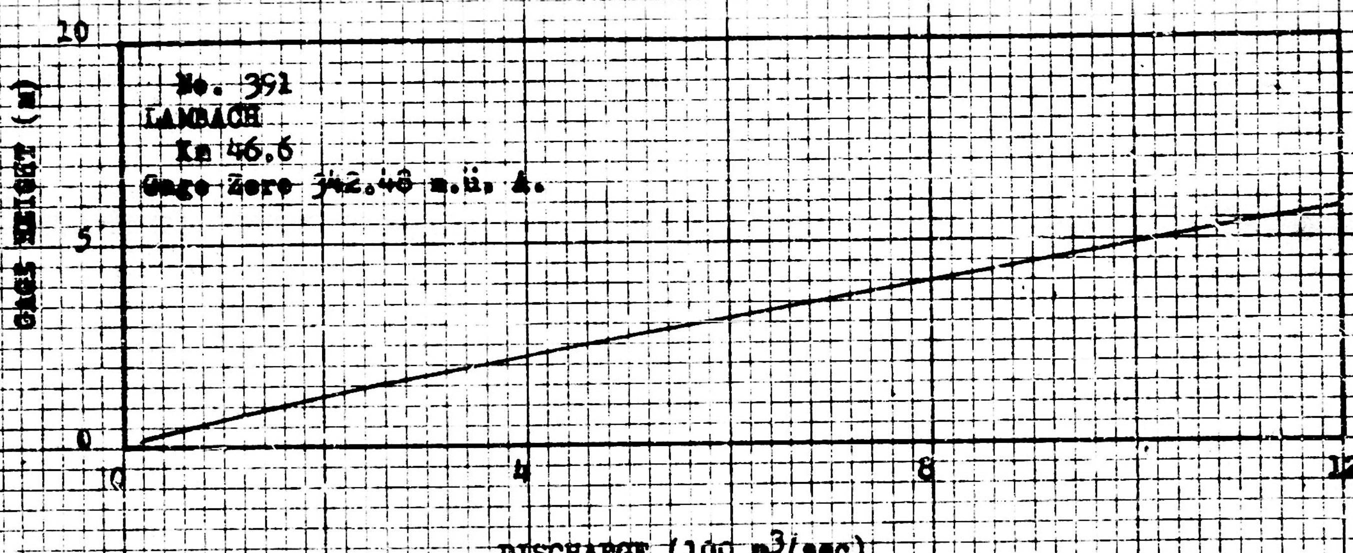
SALZACH RIVER

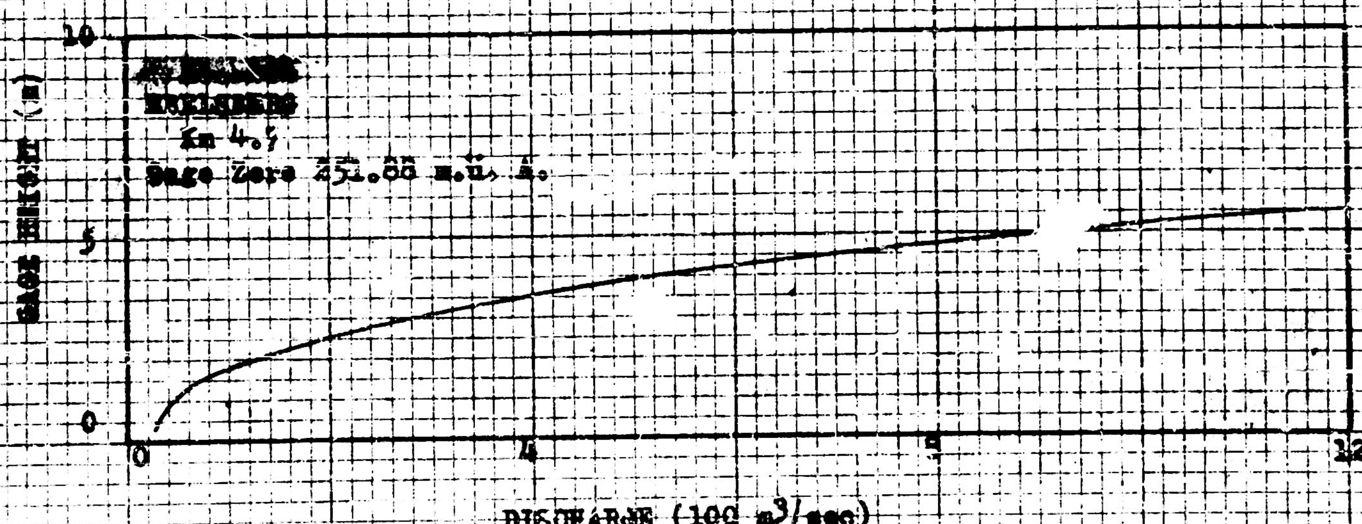
MILITARY HYDROLOGY P. & D. BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by J.O.B. Date Nov. 1953
Drawn by J.H.

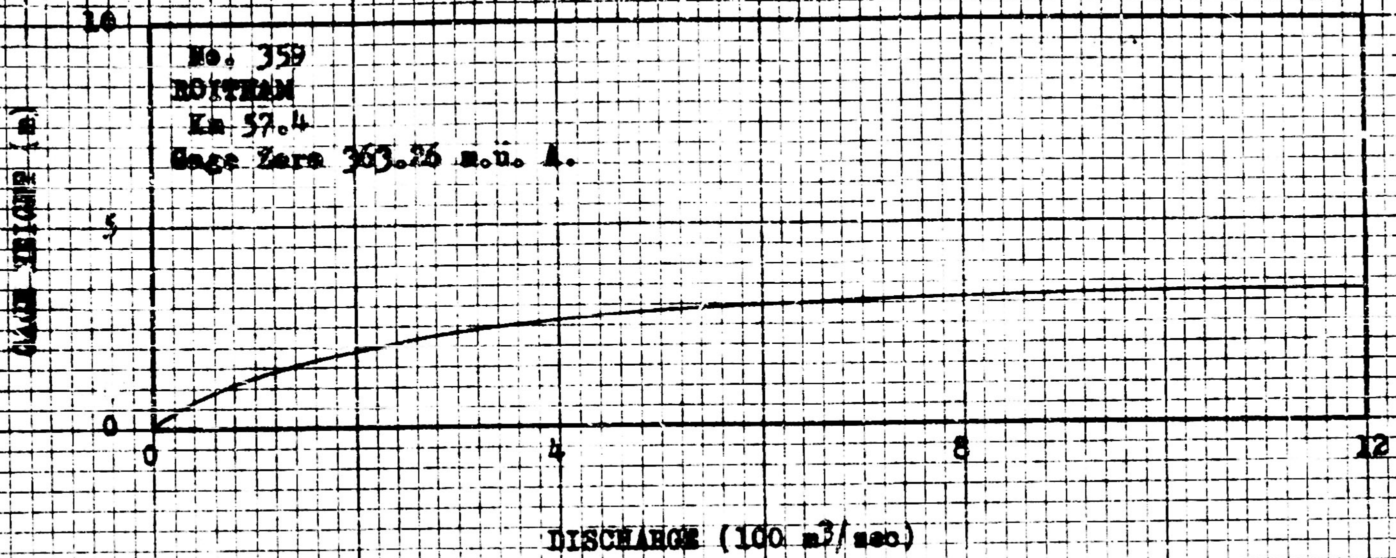
RESTR
SECURITY IN

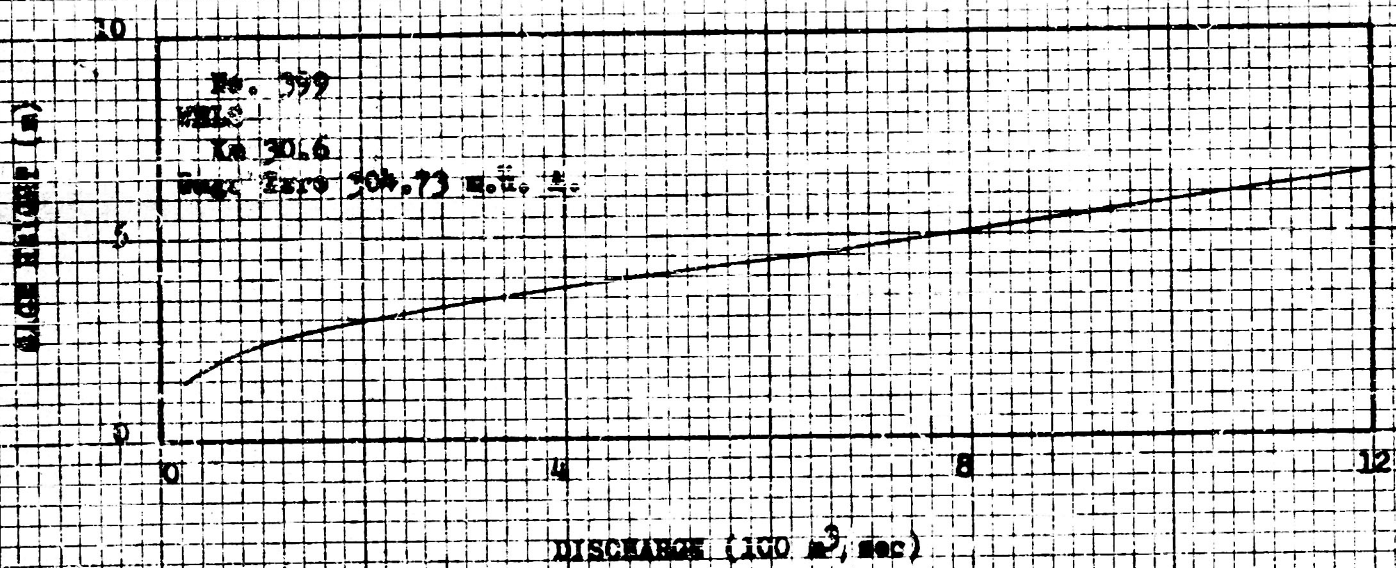






TRICTED
INFORMATION





RESTRICTED
SECURITY INFORMATION

LEGEND

———— Limit of Observed Data

— — — — Estimated Extension

NOTE: Curves shown are estimated.

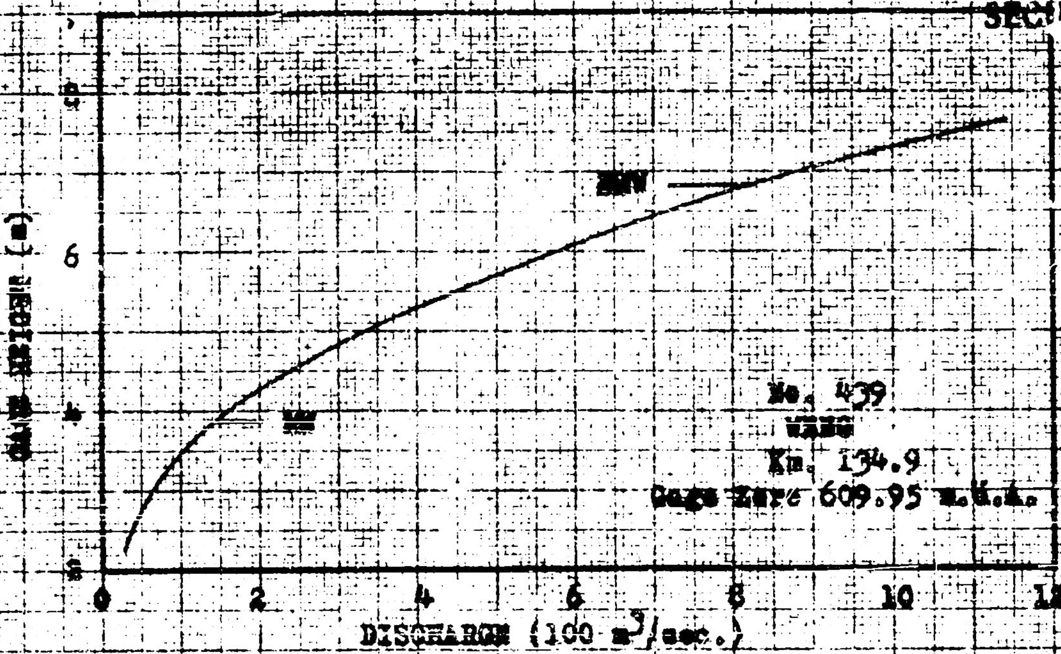
AUSTRIAN ALPS

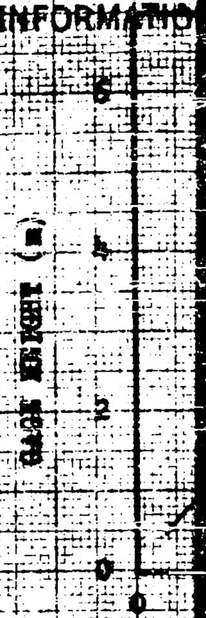
DISCHARGE RATING CURVES
TRAUN RIVER

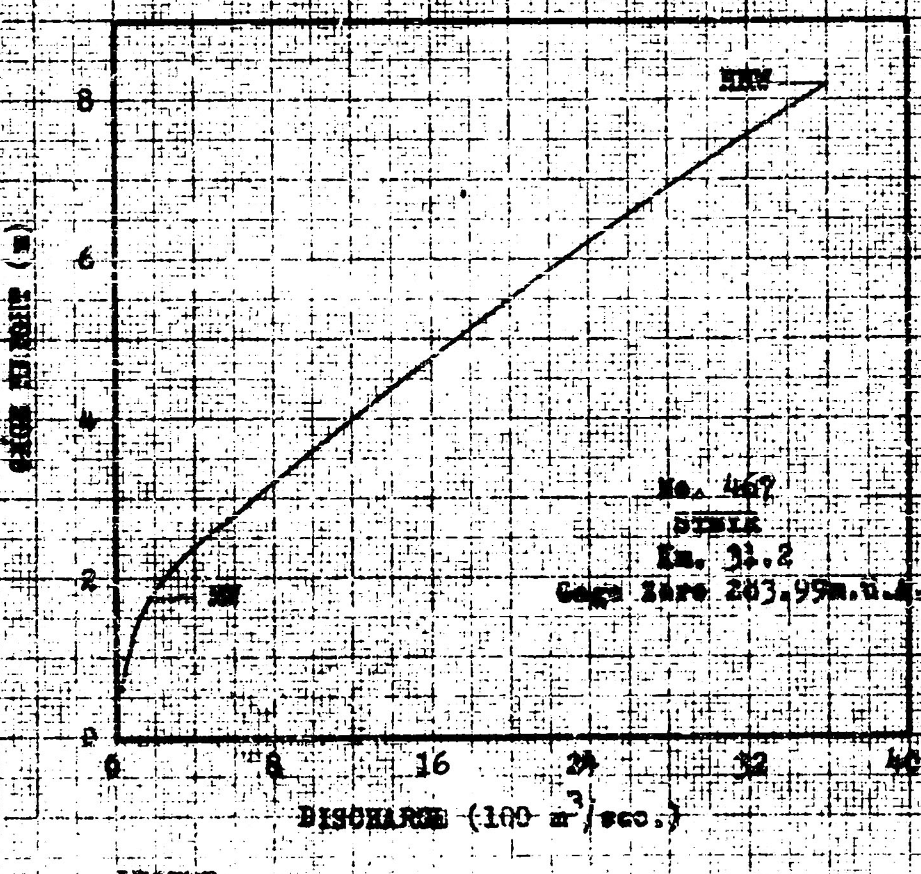
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JDB Date Nov 1953
Drawn by ...

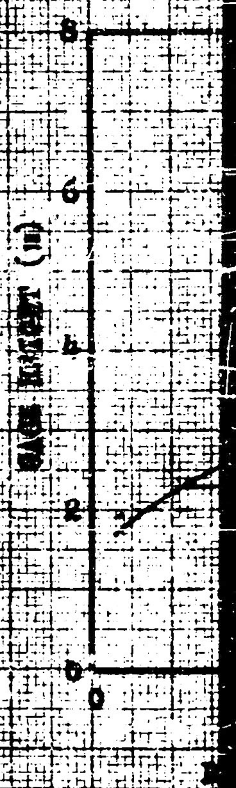
PLATE 8c

RESTRICTED
SECURITY INFORMATION



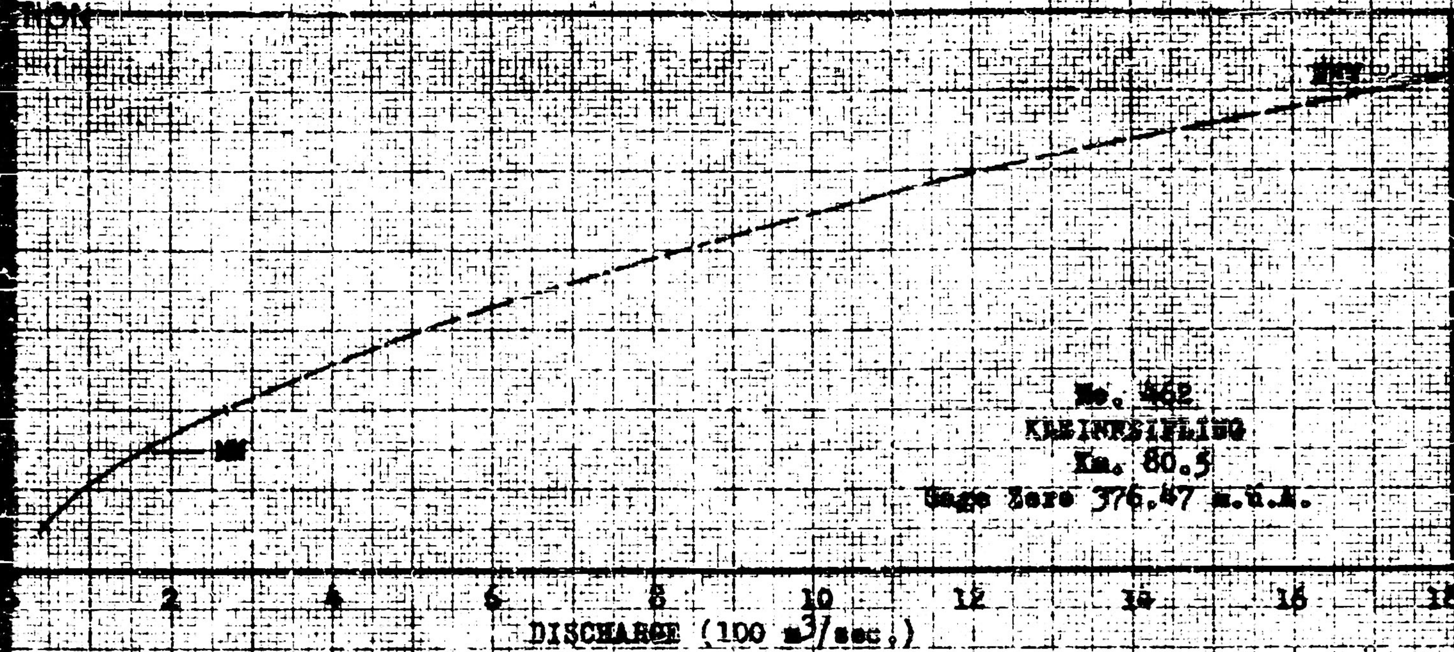


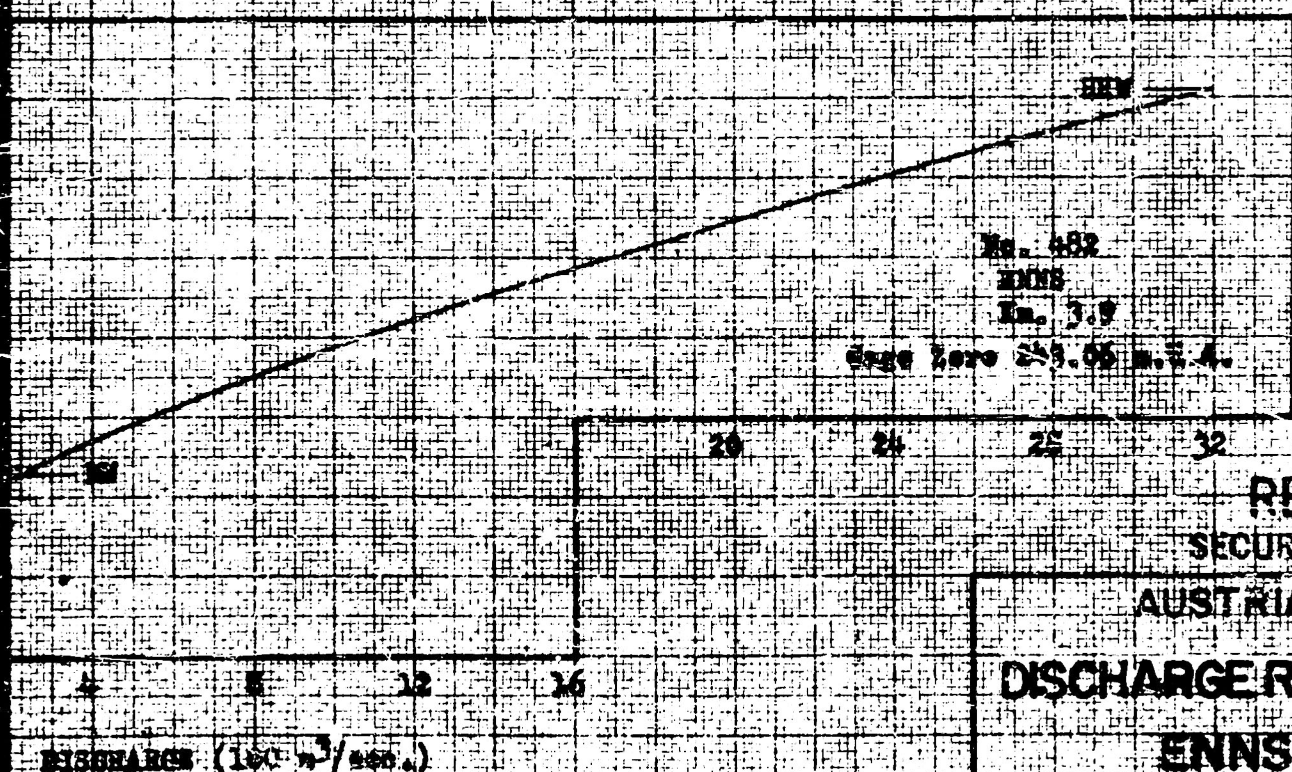




LEGEND
—— Limit of Observed Data

NOTE:





---- Estimated Extension

: Curves shown are estimated.

RESTRICTED
SECURITY INFORMATION

AUSTRIAN ALPS

DISCHARGE RATING CURVES
ENNS RIVER

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JJB Date Nov 1953
Drawn by JJB

PLATE 8d

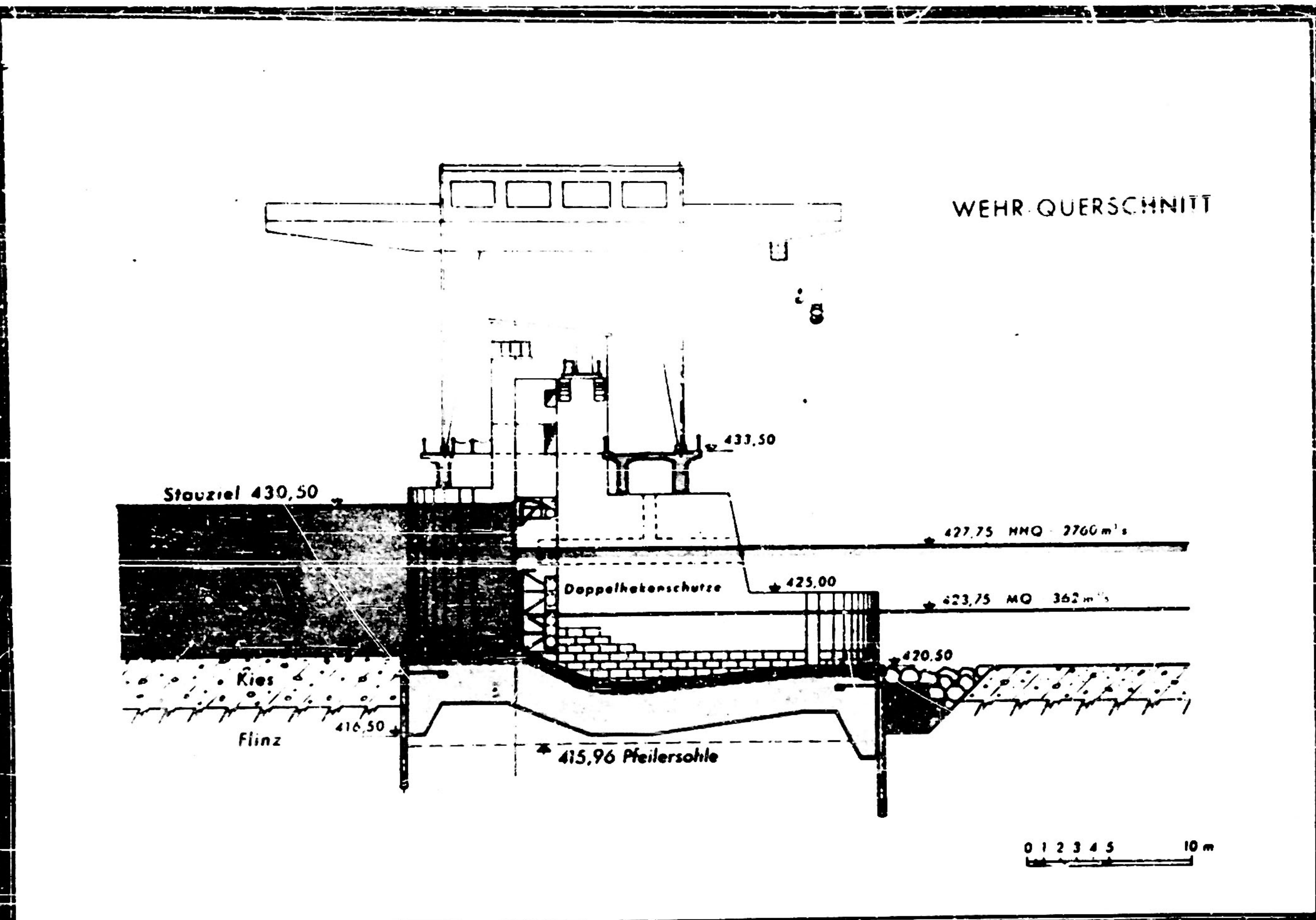


Fig. I CROSS SECTION

Fig. III VIEW OF WEIR FROM RIGHT BANK

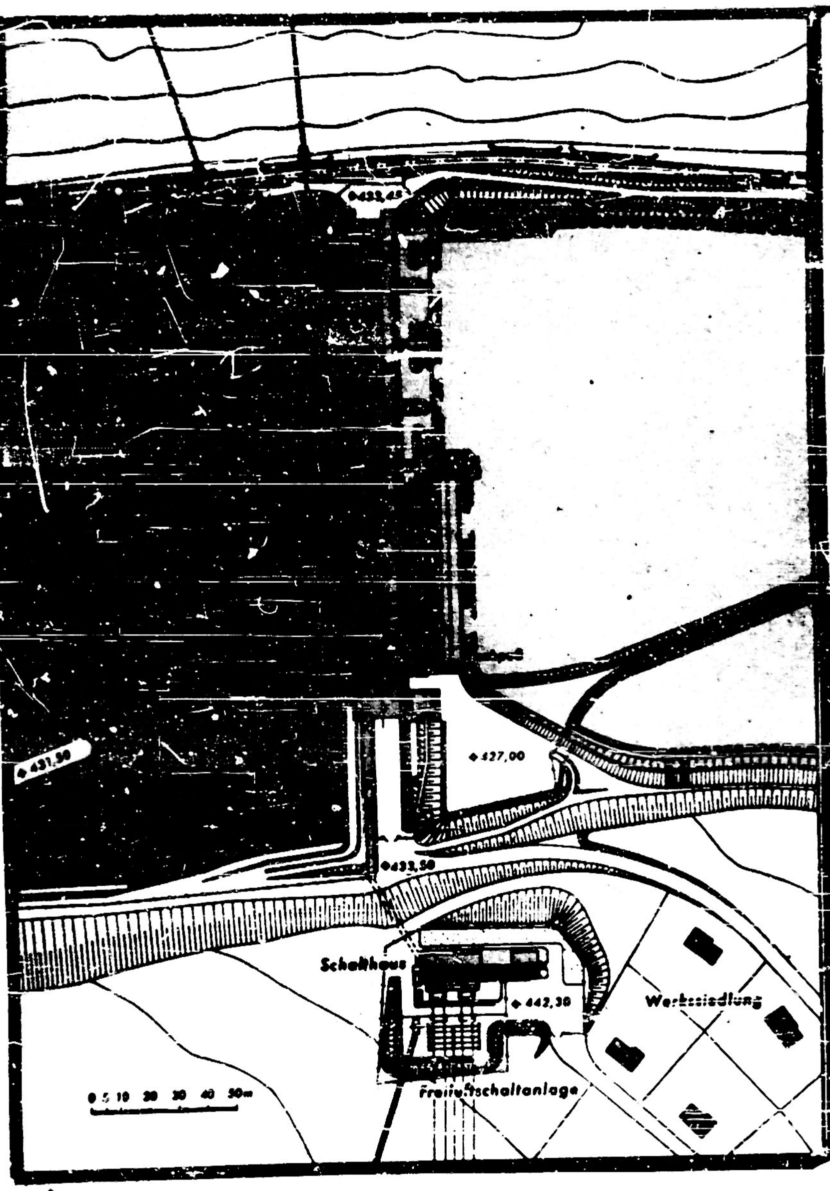


Fig. II PLAN

SOURCE:

Reference No. 41

AUSTRIAN ALPS

SKETCHES OF DAMS
WASSERBURG WEIR
INN RIVER

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JVH Date Nov. 1953
Drawn by

PLATE 9 a

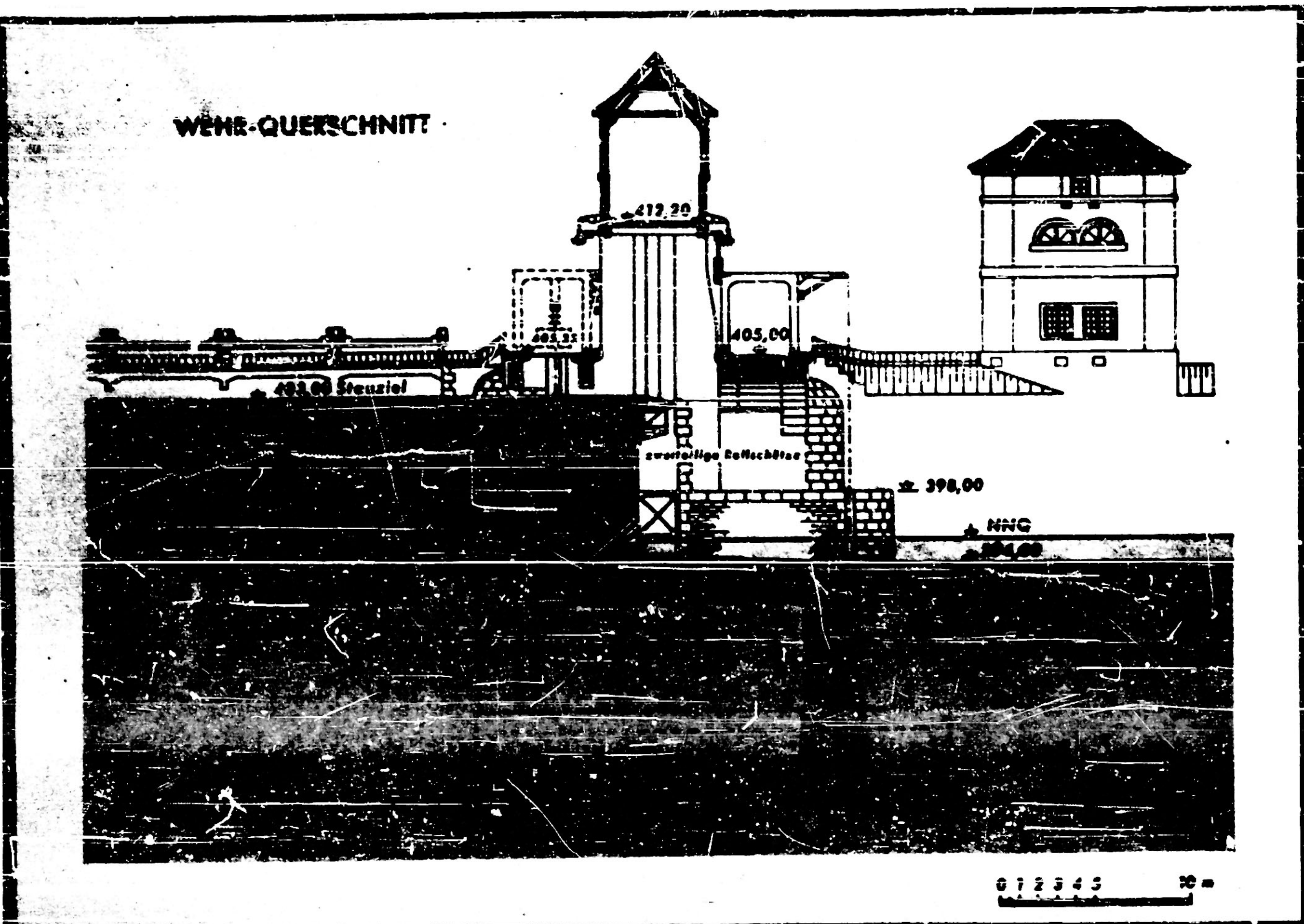


Fig. I CROSS SECTION

Fig. III VIEW OF WEIR FROM DOWNSTREAM

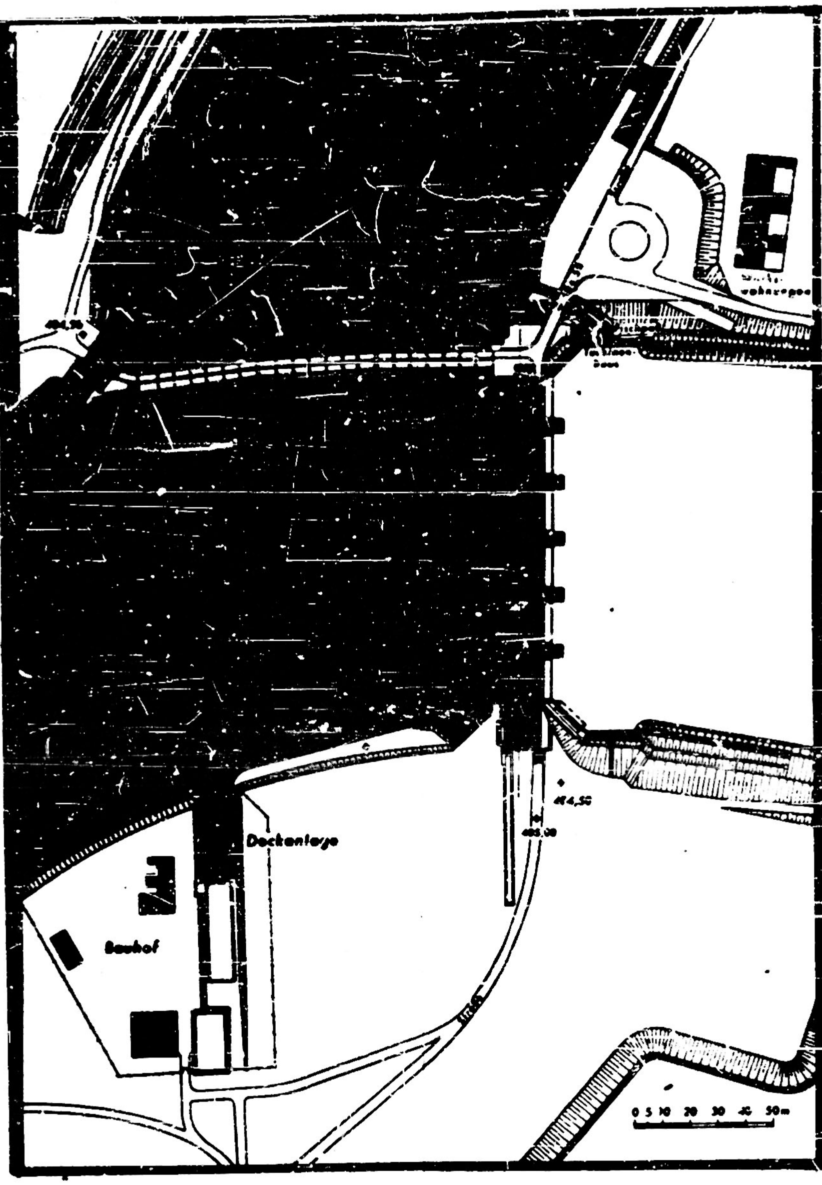


Fig. II PLAN

SOURCE:

Reference No. 41

AUSTRIAN ALPS
SKETCHES OF DAMS
JETTENBACH WEIR
INN RIVER

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by J.J.H. Date May 1953
Drawn by ____________

PLATE 9b

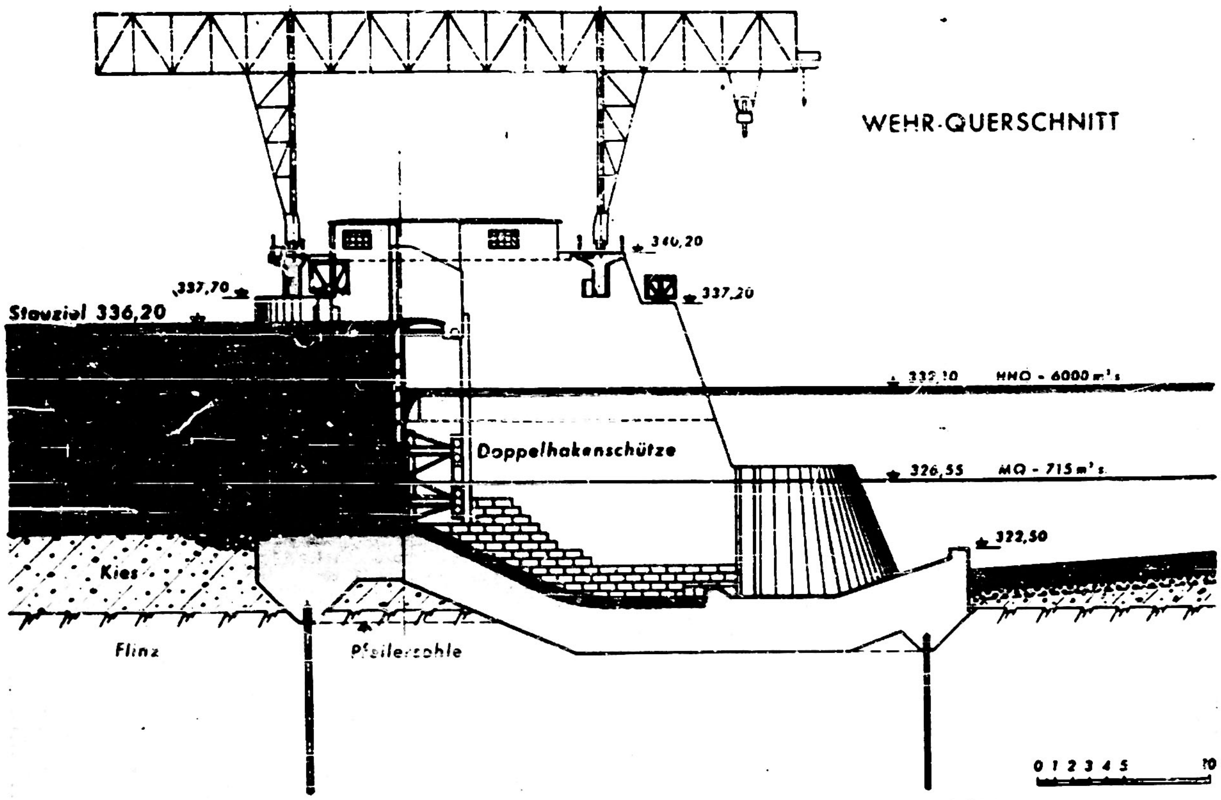


Fig. I CROSS SECTION

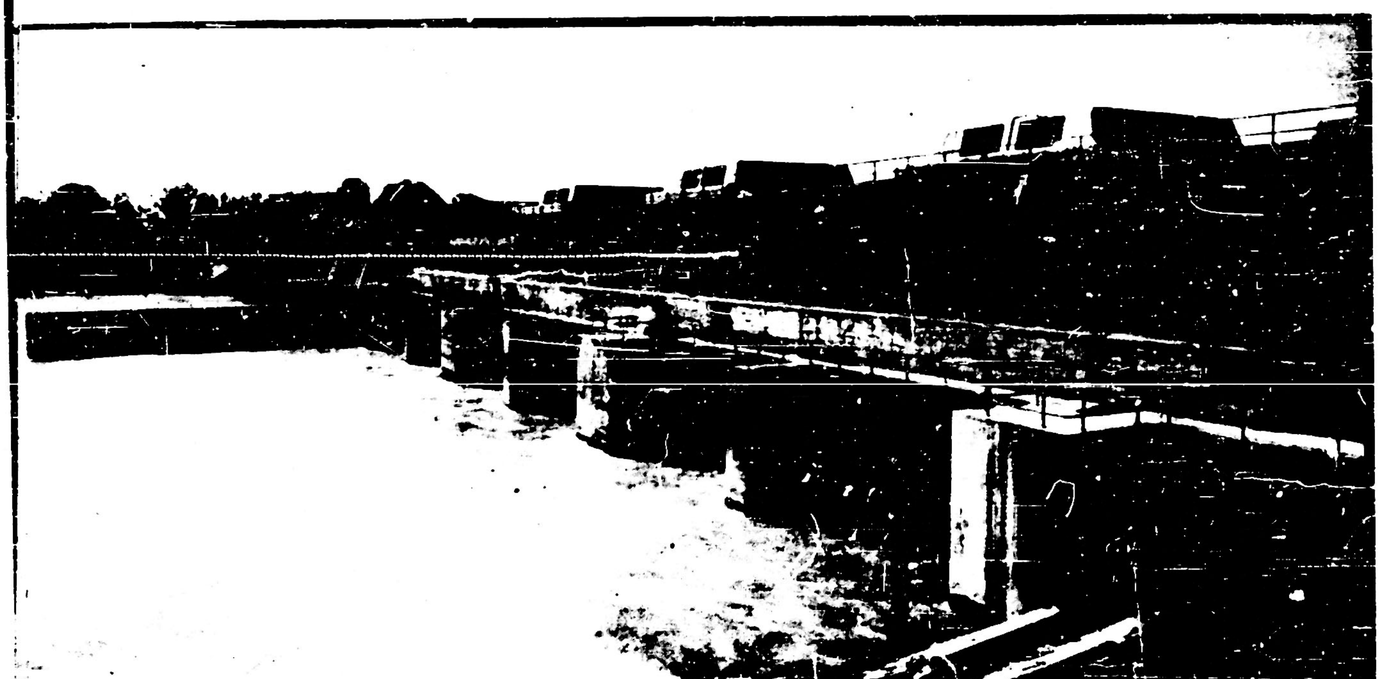


Fig. III VIEW OF WEIR FROM DOWNSTREAM

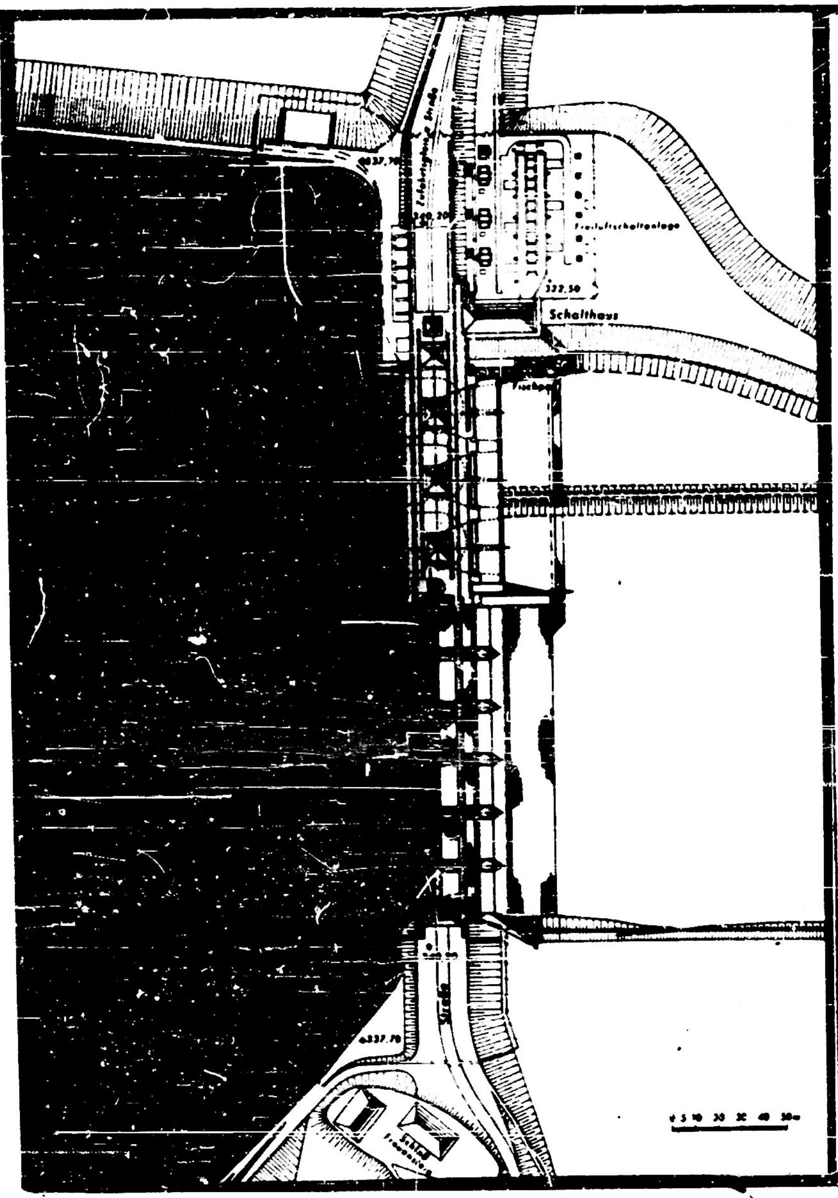


Fig. II PLAN

SOURCE:

Reference No. 41

AUSTRIAN ALPS

SKETCHES OF DAMS

ERING WEIR

INN RIVER

MILITARY HYDROLOGY R & D BRANCH

WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by J.J.H. Date Nov. 1953

Drawn by ________

PLATE 9c

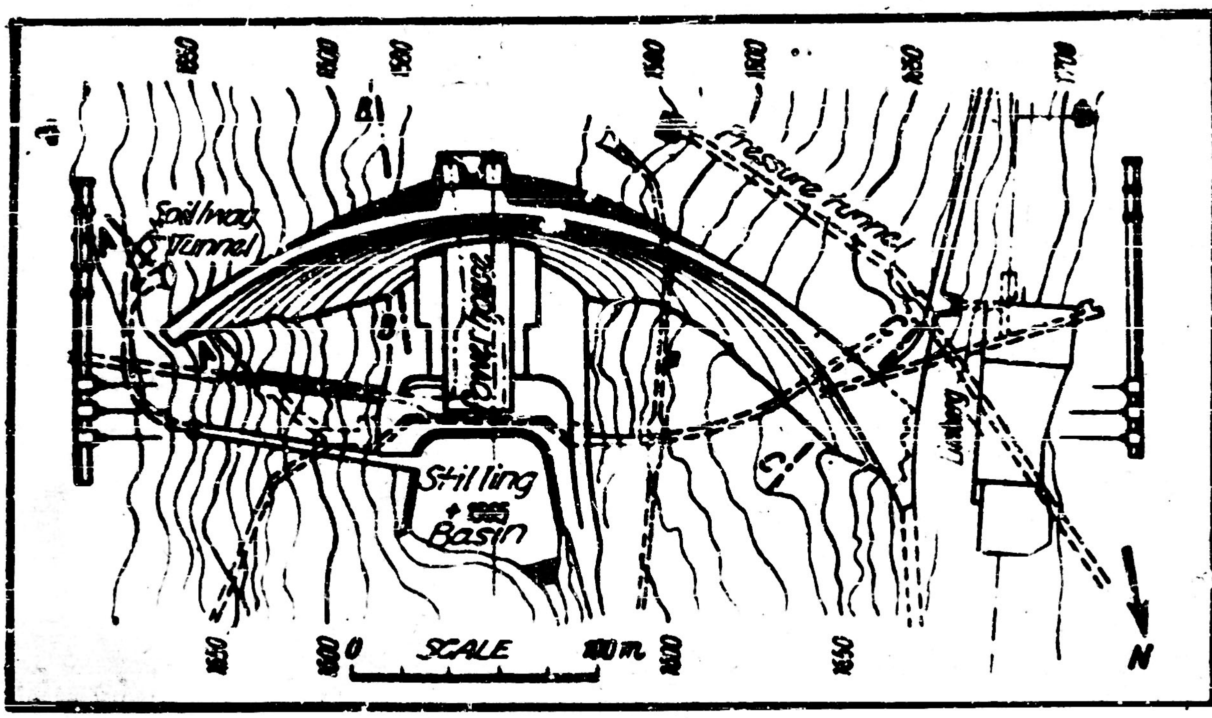


Fig. I PLAN

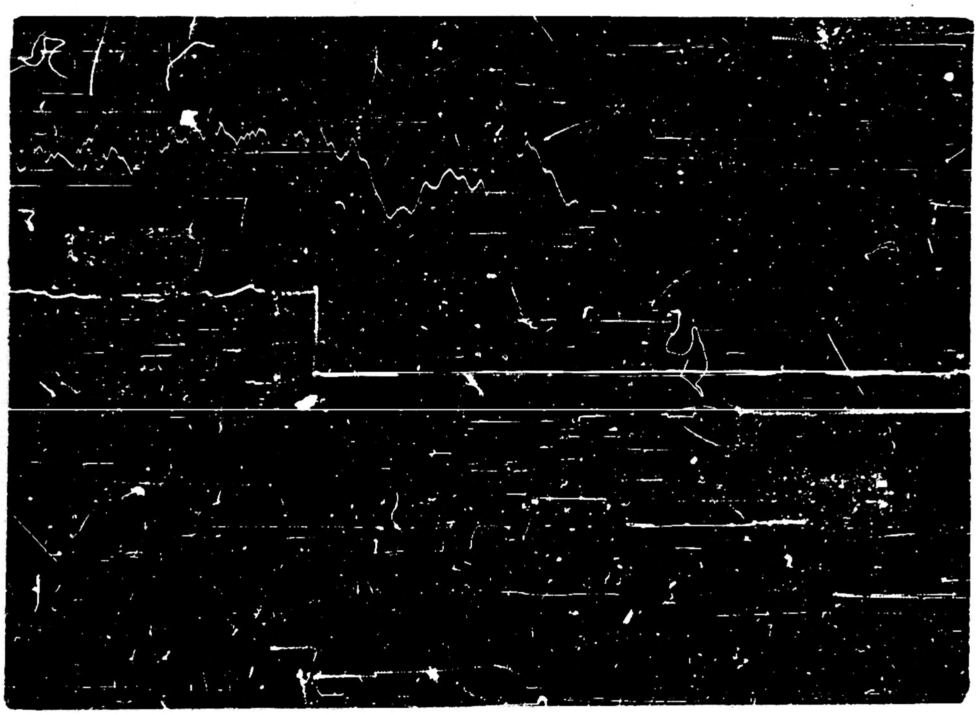


Fig. III GENERAL VIEW OF DAM

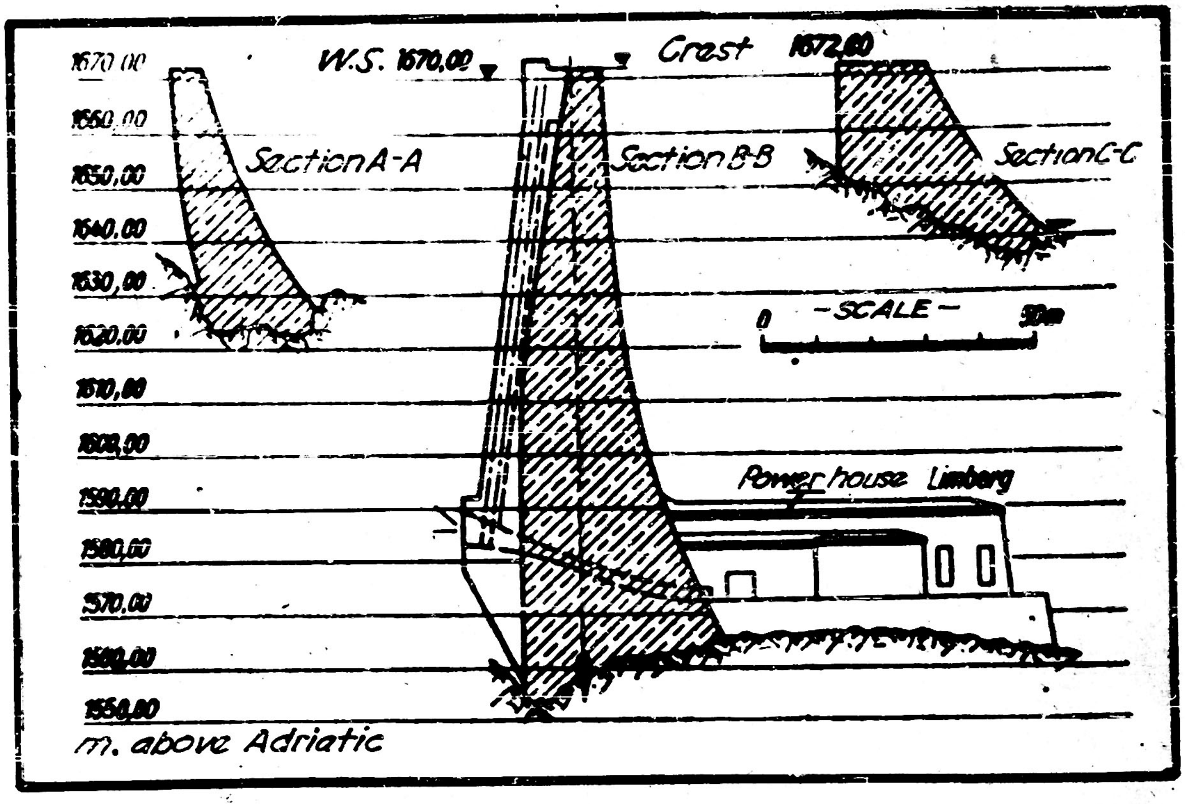


Fig. II CROSS SECTION

SOURCE:
Fig. I & II Reference No. 58
Fig. III Reference No. 87

AUSTRIAN ALPS
SKETCHES OF DAMS
LIMBURG DAM
SALZACH R. (KAPRUN A.)

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by LJH Date Nov. 1953
Drawn by

PLATE 9 d

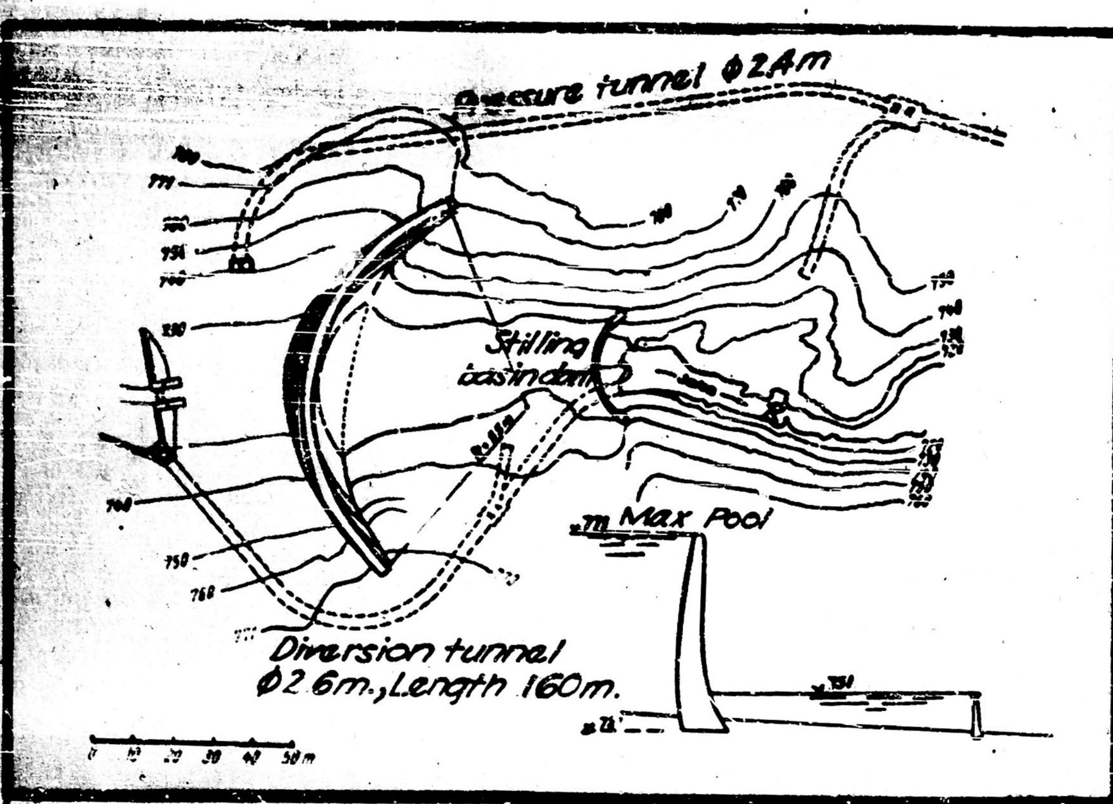


Fig. I SALZA DAM - PLAN & CROSS SECTION

Fi

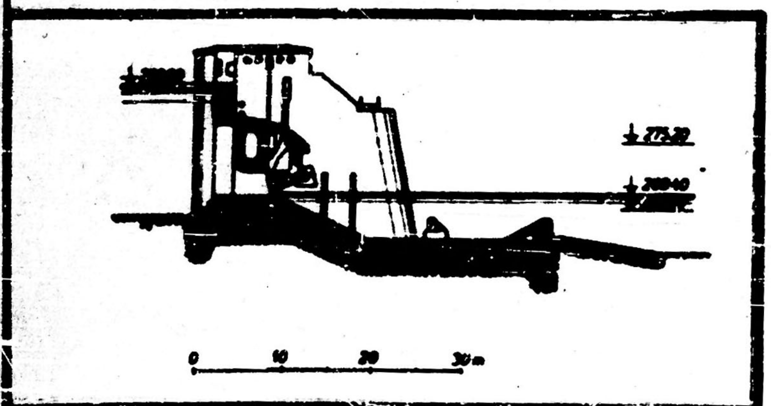


Fig. IV STANING WEIR
CROSS SECTION

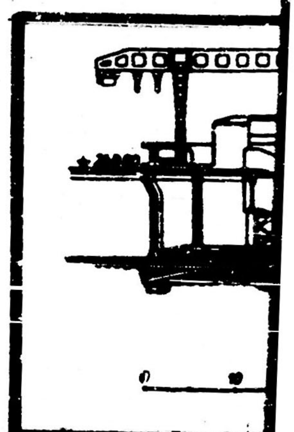
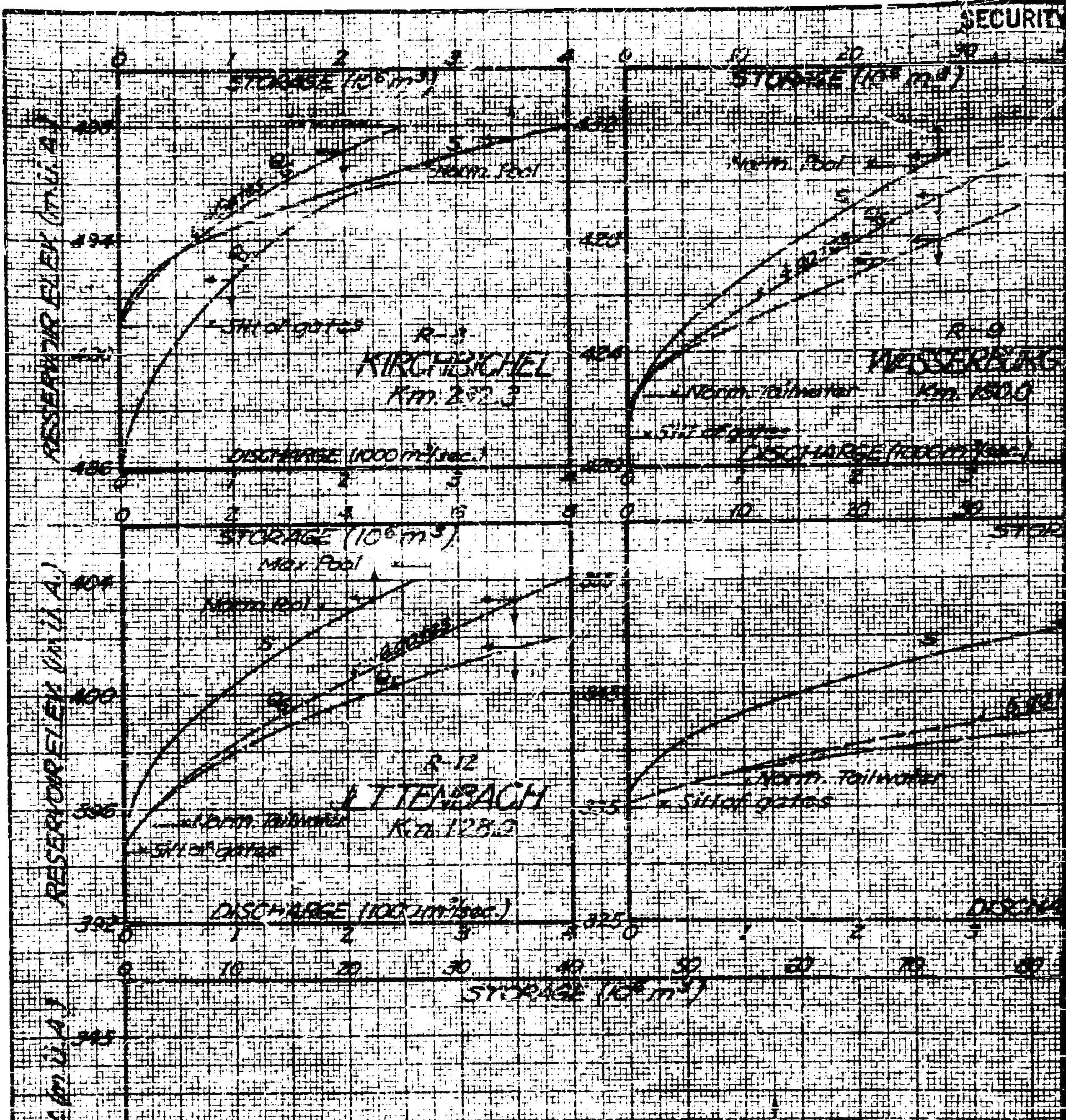
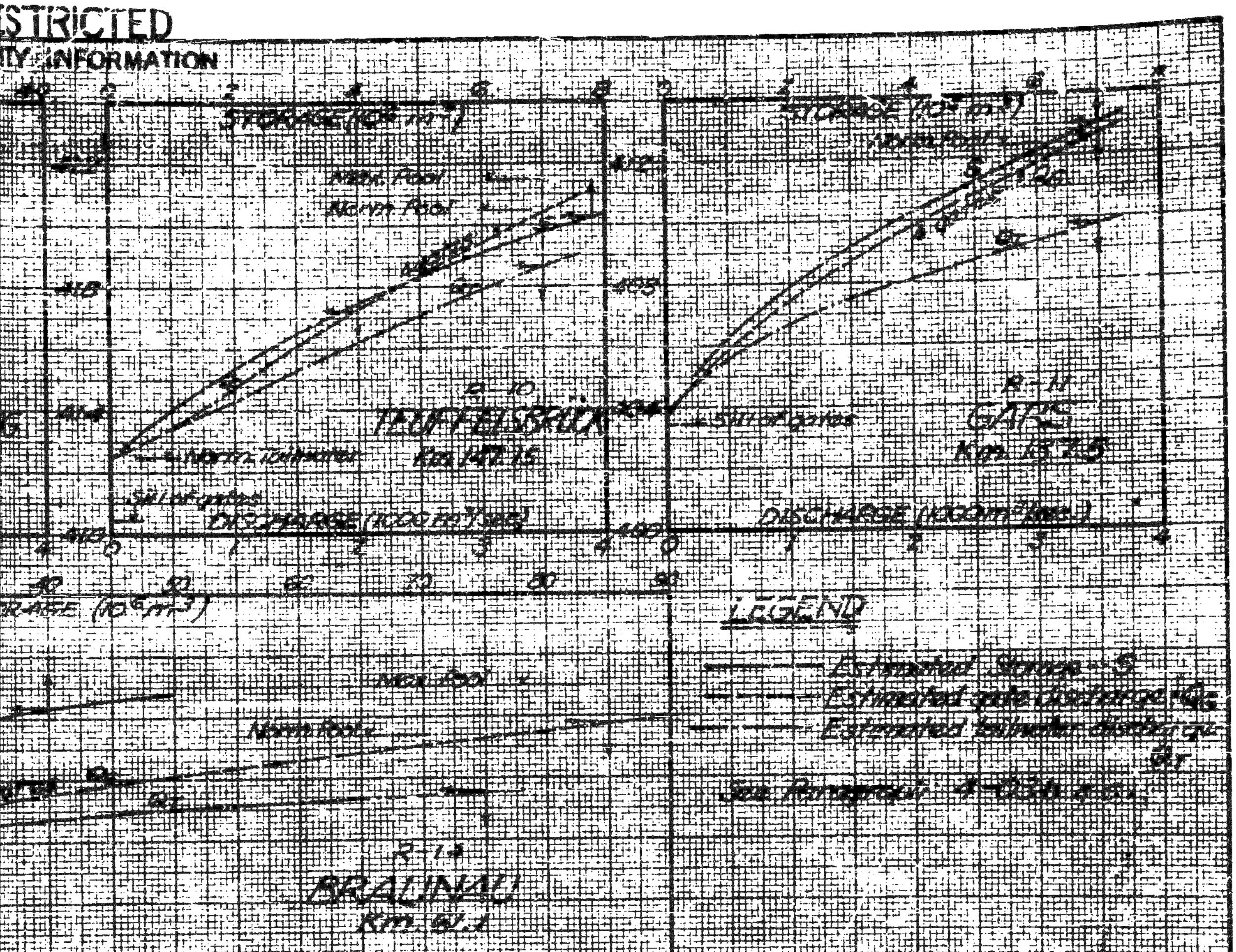


Fig.V
CROS

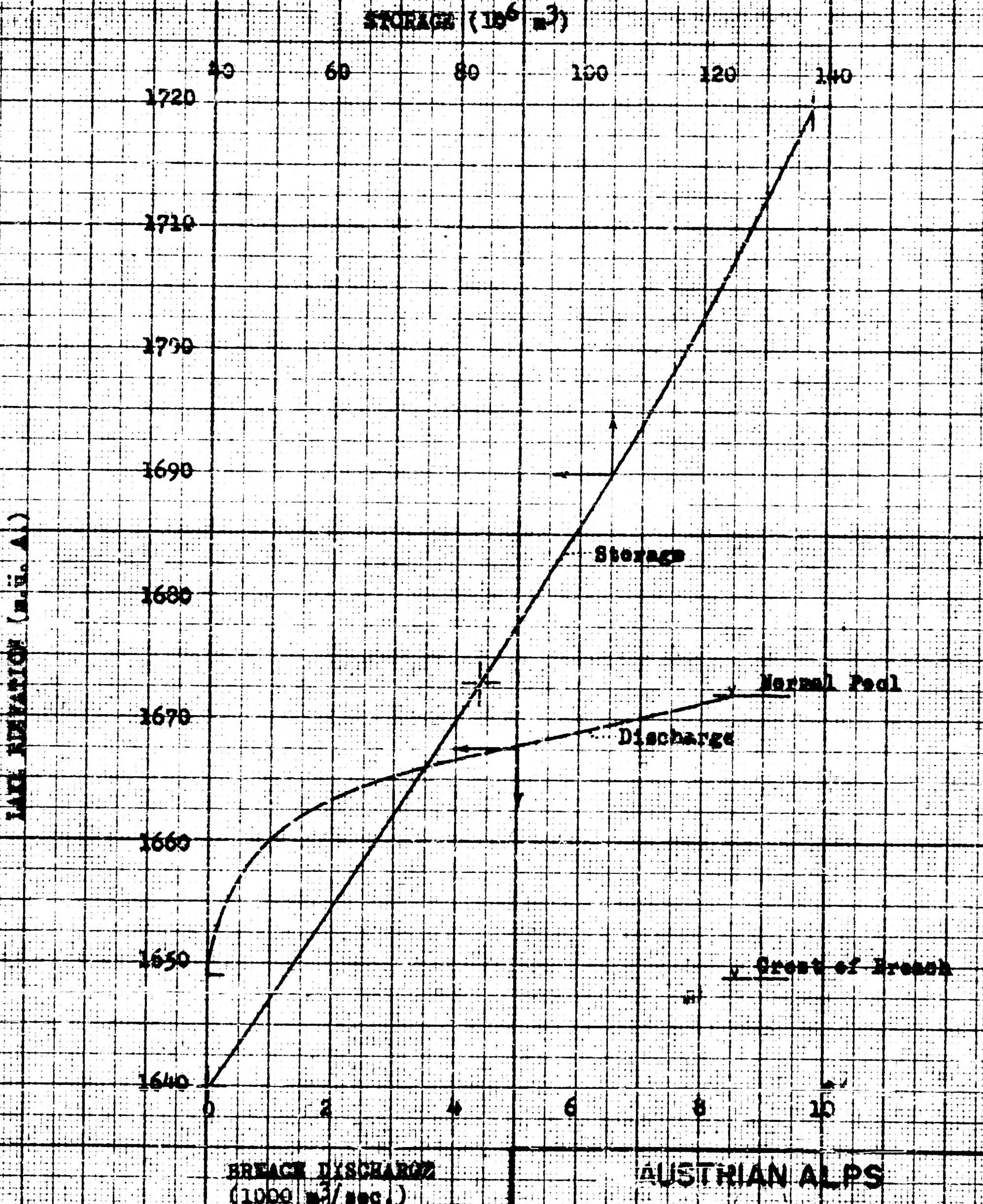

STORAGE ($10^6 m^3$)
RESERVOIR ELEV. (m. U.A.)
Norm. Pool
Sill of gates
R-3
KIRCHBICHEL
Km. 222.3
DISCHARGE (1000 m³/sec.)
Norm. Pool
R-9
Norm. Tailwater
Sill of gates
Km. 180.0
Max. Pool
Norm. Pool
R-12
Norm. Tailwater
Sill of gates
Km. 128.3
Norm. Tailwater
Sill of gates
Norm. Pool
Norm. Tailwater
Sill of gates
Km. 48.
DISCHARGE (1000 m³/sec.)



STRICTED
ITY INFORMATION
STORAGE (10⁶ m³)
Max. Pool
Norm. Pool
R-10
TEUFELSBRÜCK
Km. 147.15
DISCHARGE (1000 m³/sec.)
R-11
GARS
DISCHARGE (1000 m³/sec.)
LEGEND
Estimated Storage - S
Estimated gate discharge
Estimated tailwater discharge
Max. Pool
Norm. Pool
R-14
BRAUNAU
RESTRICTED
SECURITY INFORMATION
STORAGE (10⁶ m³)
Norm. Pool
R-16
EGGLFING
Km. 35.5
DISCHARGE (1000 m³/sec.)
AUSTRIAN ALPS
RESERVOIR STORAGE
& DISCHARGE CURVES
INN RIVER
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by
Drawn by

PLATE 10 a

RESTRICTED
SECURITY INFORMATION



LEGEND
Estimated Storage
Estimated Breach Discharge
Data from Ref. No. 45, 68 & 75
(See Paragraph 4-62 b&c)

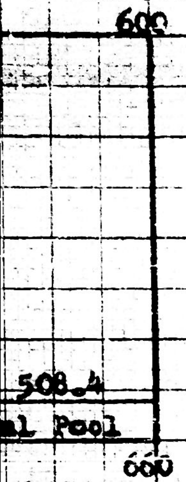
RESTRICTED
SECURITY INFORMATION

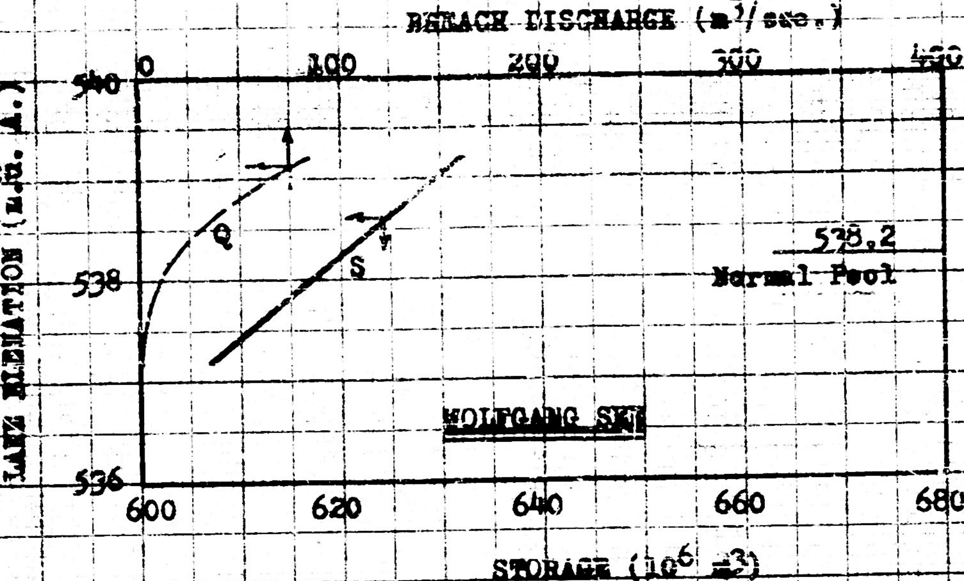
AUSTRIAN ALPS
RESERVOIR STORAGE & DISCHARGE CURVES
LIMBURG DAM

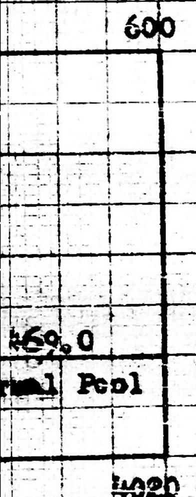
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JBB Date Nov 1952
Drawn by JJH

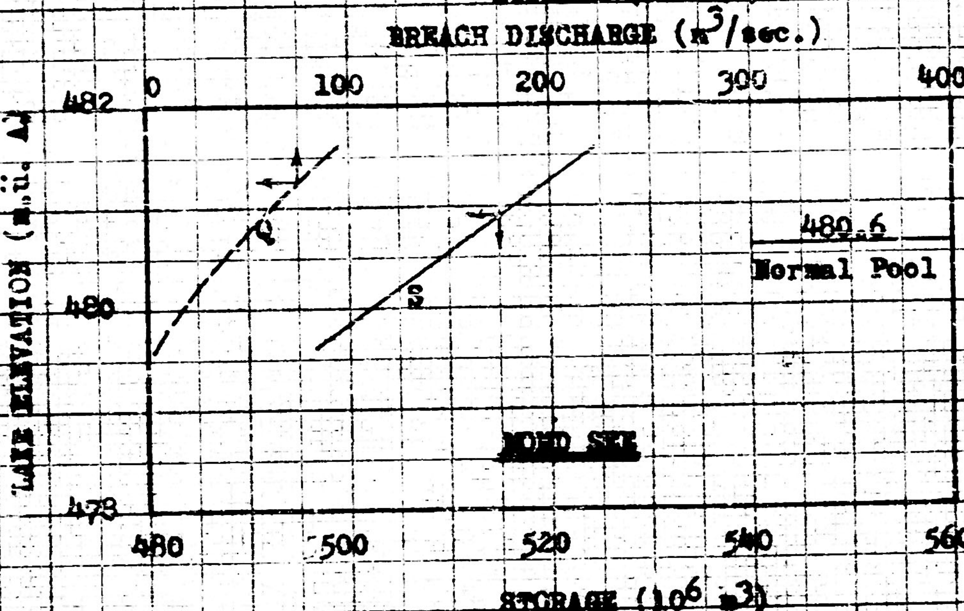
PLATE 10 b

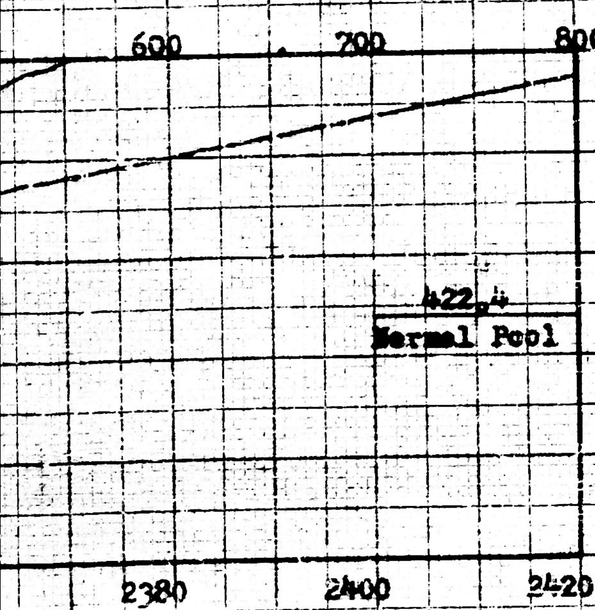
ESTRICTED
RITY INFORMATION











LEGEND

Estimated Storage

Estimated Breach Discharge

(See Paragraph 4-02 b4) RESTRICTED
SECURITY INFORMATION

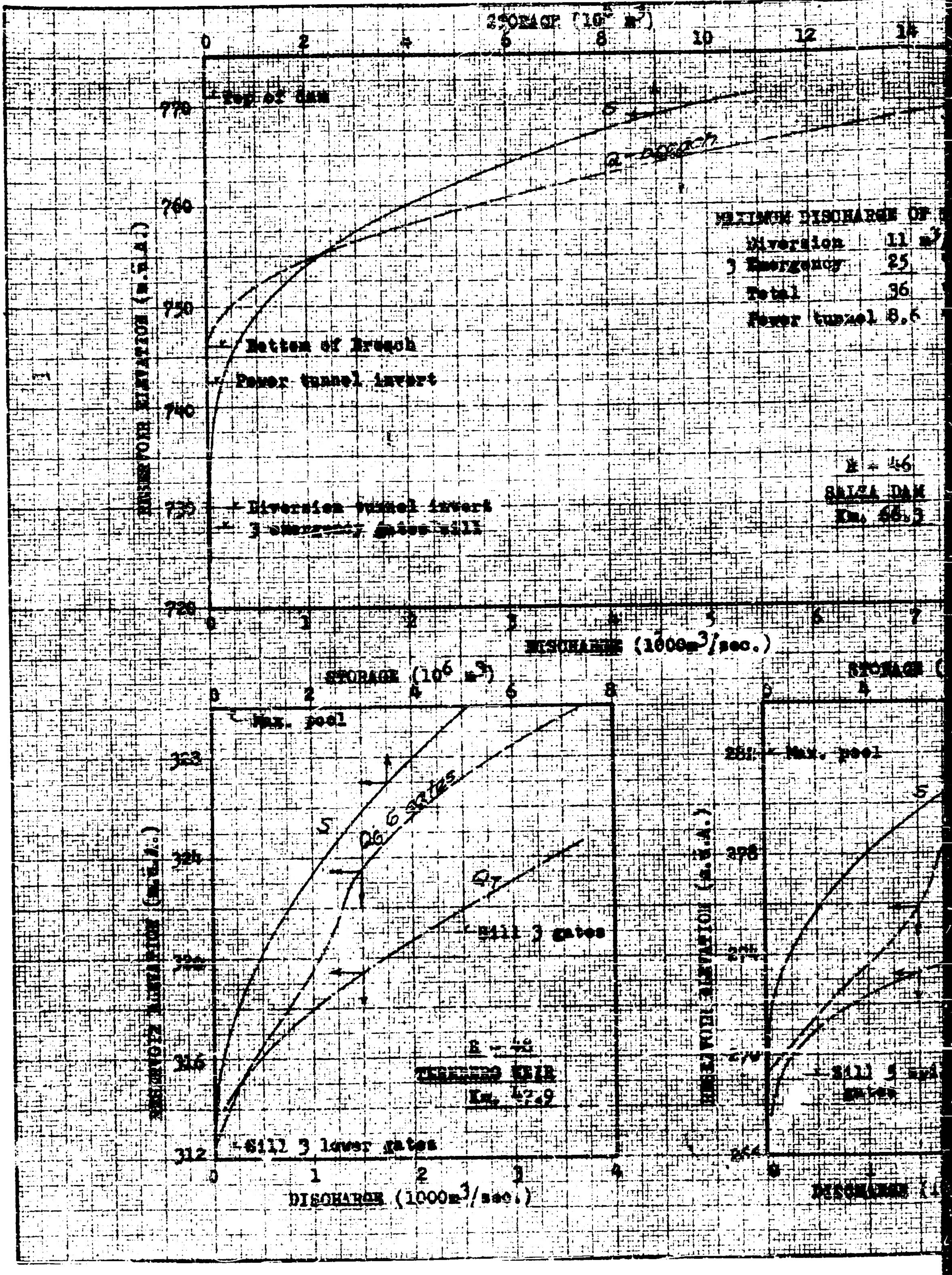
AUSTRIAN ALPS

RESERVOIR STORAGE
& DISCHARGE CURVES
TRAUN RIVER

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS

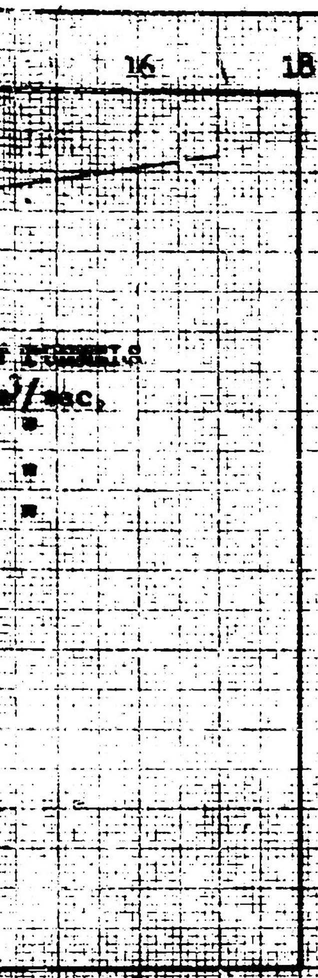
Prepared by FBB Date Nov. 1953
Drawn by JJH

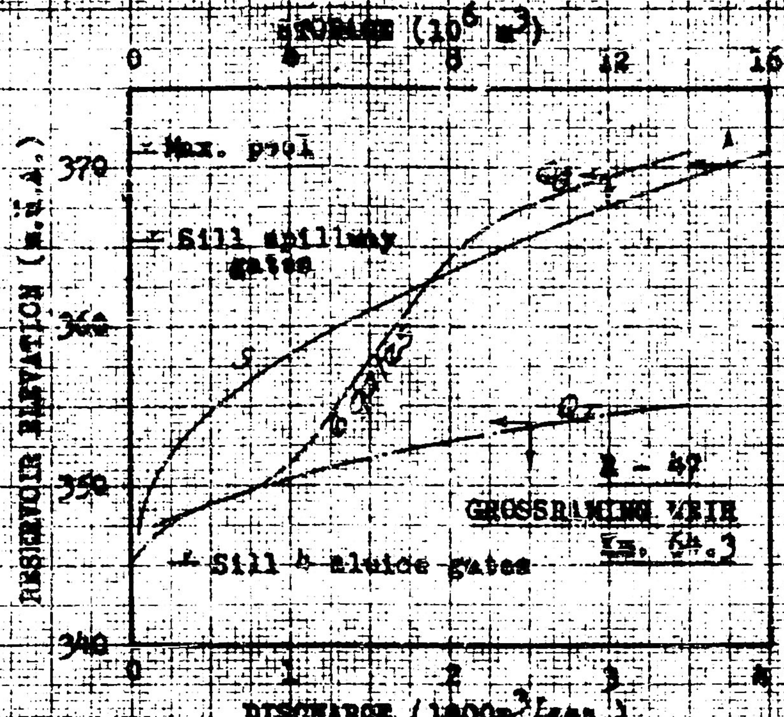
PLATE 10 c

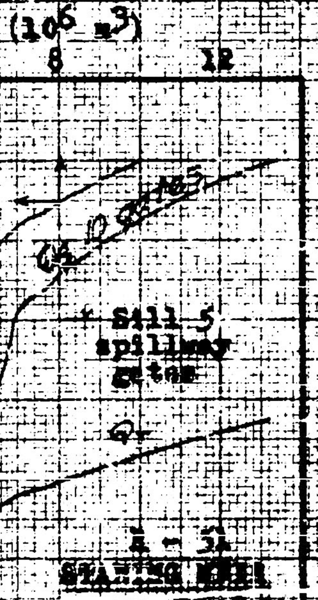


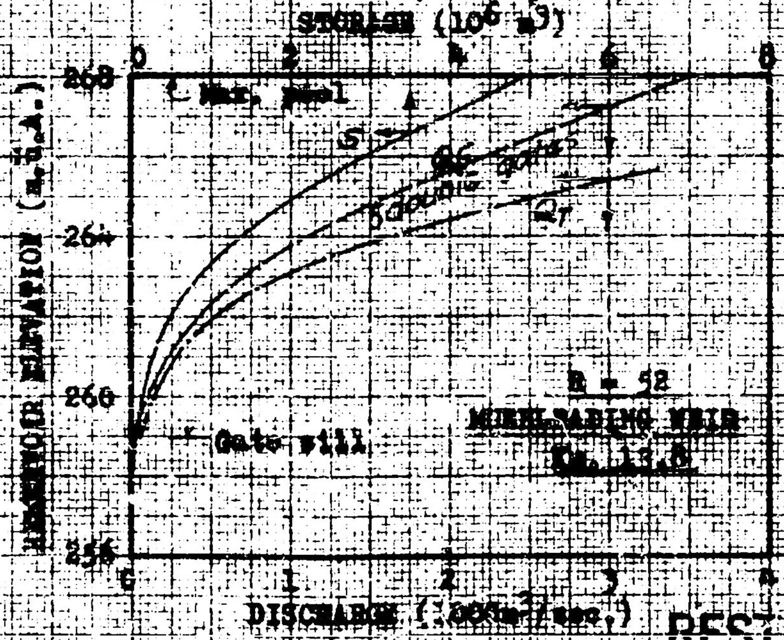
STORAGE (10^6 m^3)
Top of dam
a - breach
MAXIMUM DISCHARGE OF
Diversion 11
3 Emergency 25
Total 36
Power tunnel 8.6
Bottom of Breach
Power tunnel invert
Diversion tunnel invert
3 emergency gates sill
RESERVOIR ELEVATION (m.s.l.)
SALZA DAM
DISCHARGE (1000m^3/sec.)
STORAGE (10^6 m^3)
Max. pool
5
6 gates
Sill 3 gates
Sill 3 lower gates
DISCHARGE (1000m^3/sec.)
STORAGE
Max. pool
5

RESTRICTED
SECURITY INFORMATION









LEGEND

Estimated storage - S

Estimated gate discharge - Q_G

Estimated tailwater discharge - Q_T

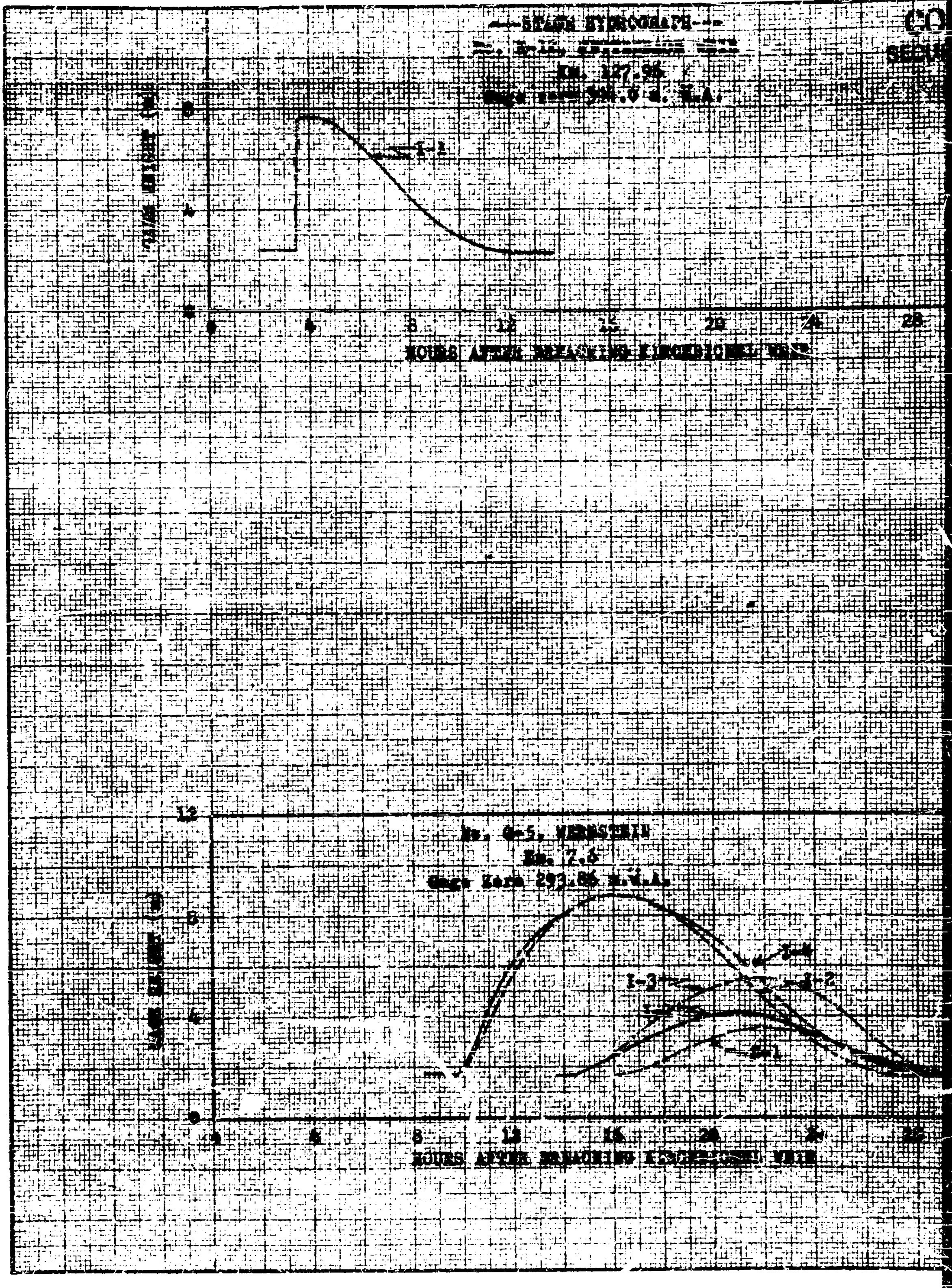
See Paragraph 4-03b & c.

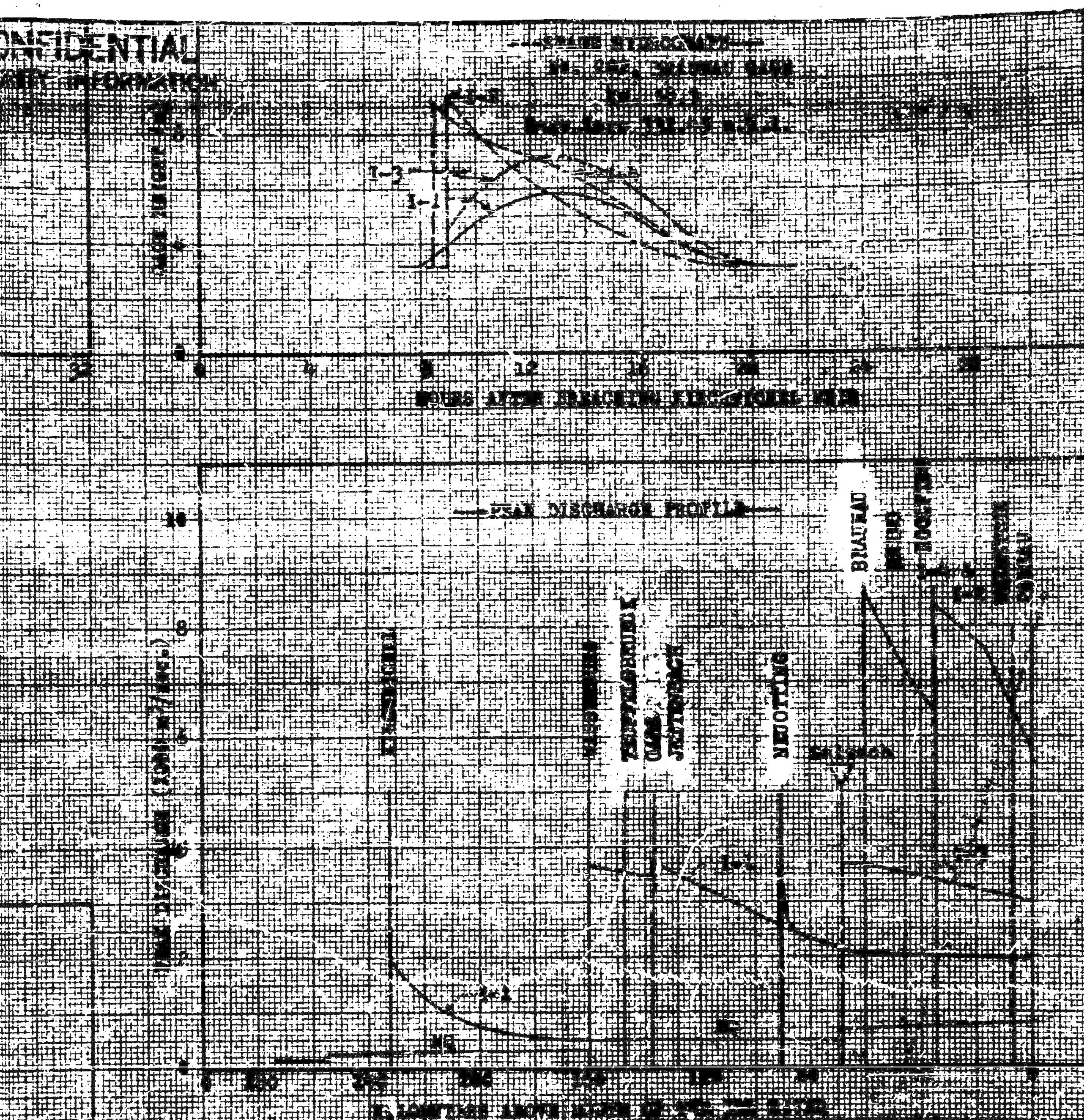
RESTRICTED
SECURITY INFORMATION

AUSTRIAN ALPS
RESERVOIR STORAGE
& DISCHARGE CURVES
ENNS RIVER

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS

Prepared by JDA Date Nov 1953
Drawn by LJK


Km. 127.96
I-2
0
4
8
12
20
24
28
HOURS AFTER BREACHING
Km. 7.6
Gage Zero 293.86
I-3
I-2
12
8
4
0
8
12
20
24
HOURS AFTER BREACHING



AUSTRIAN ALPS

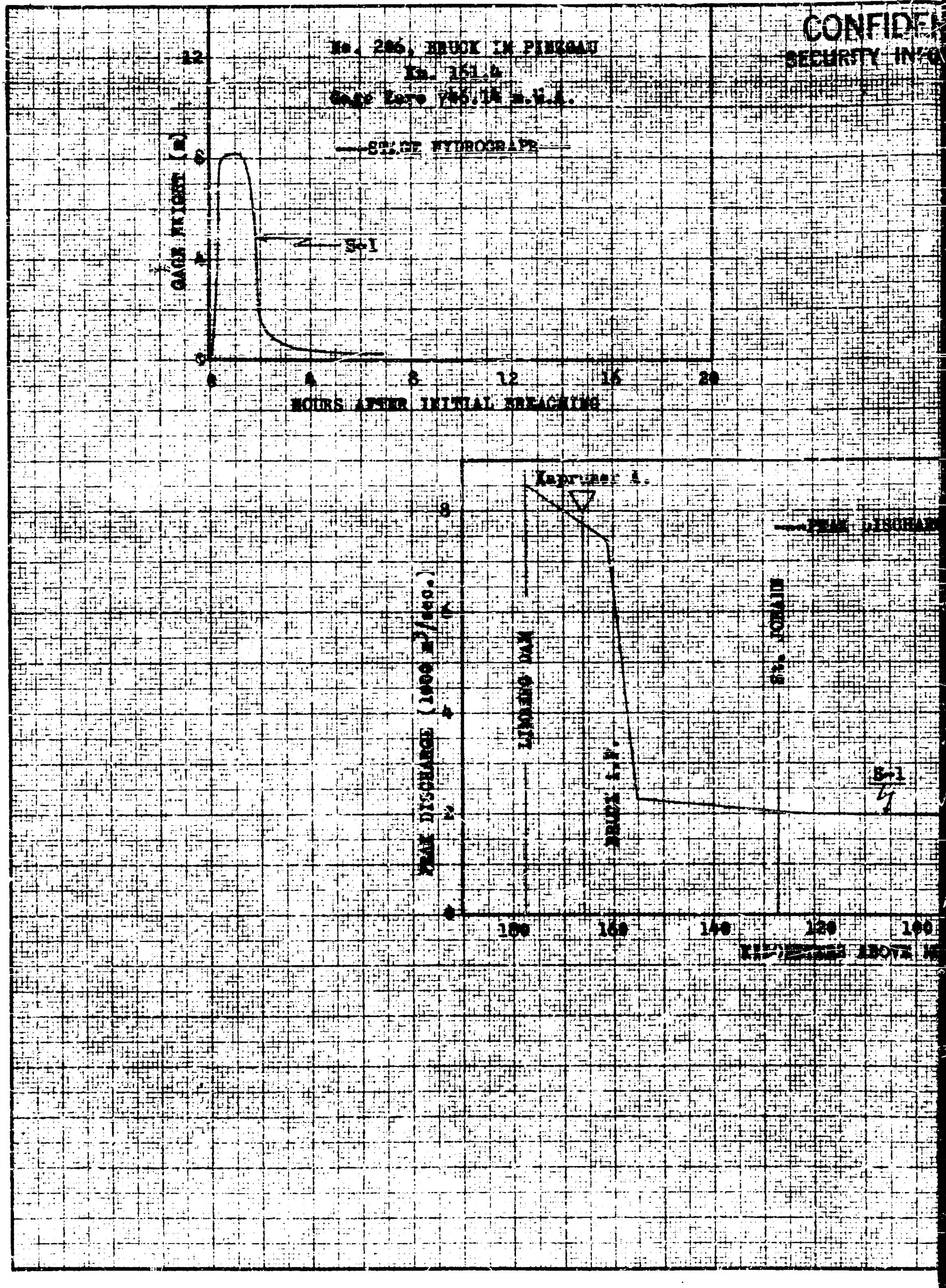
ARTIFICIAL FLOOD GRAPHS

INN RIVER

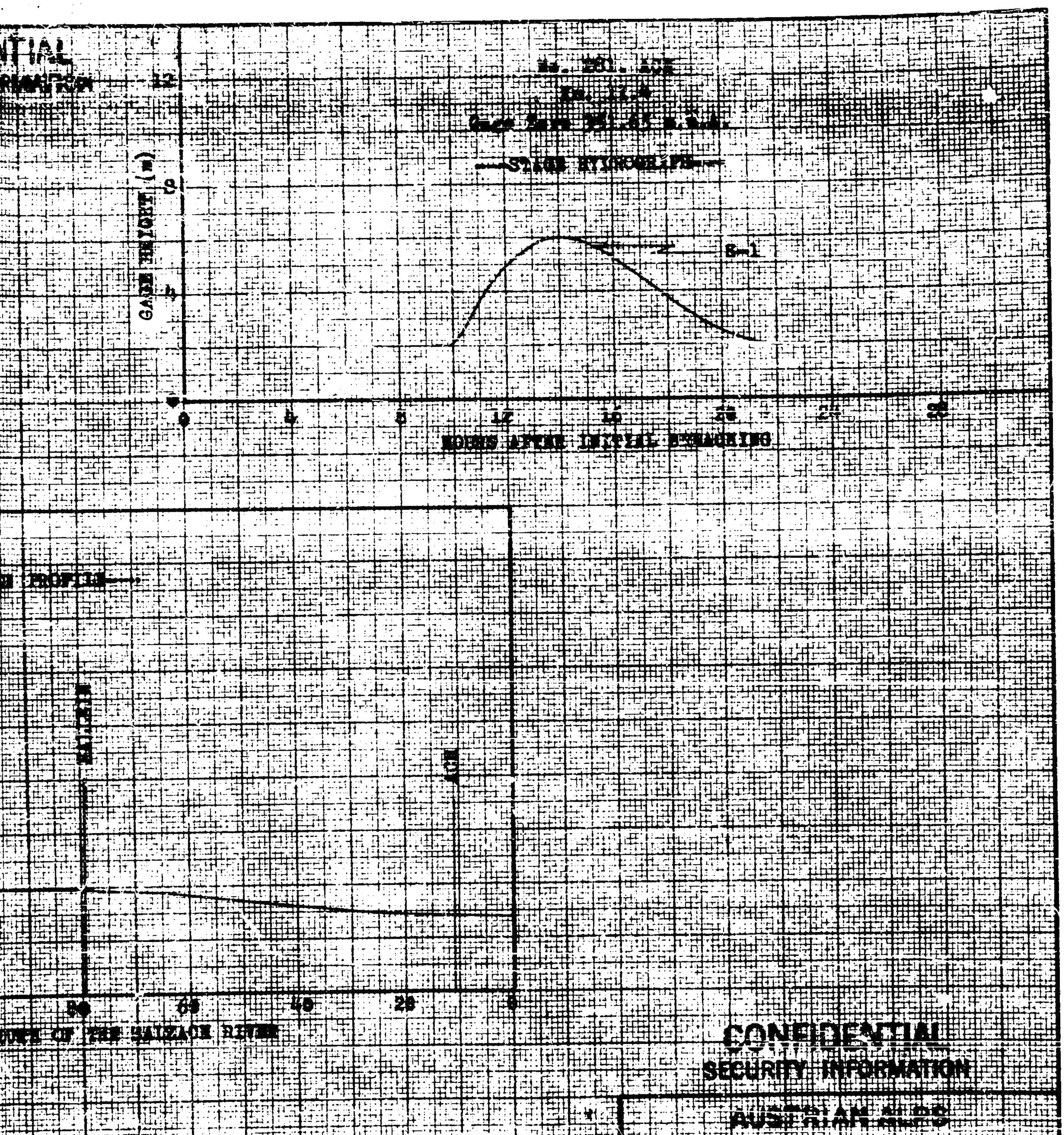
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared
Drawn by

CONFIDENTIAL
SECURITY INFORMATION

PLATE 11a

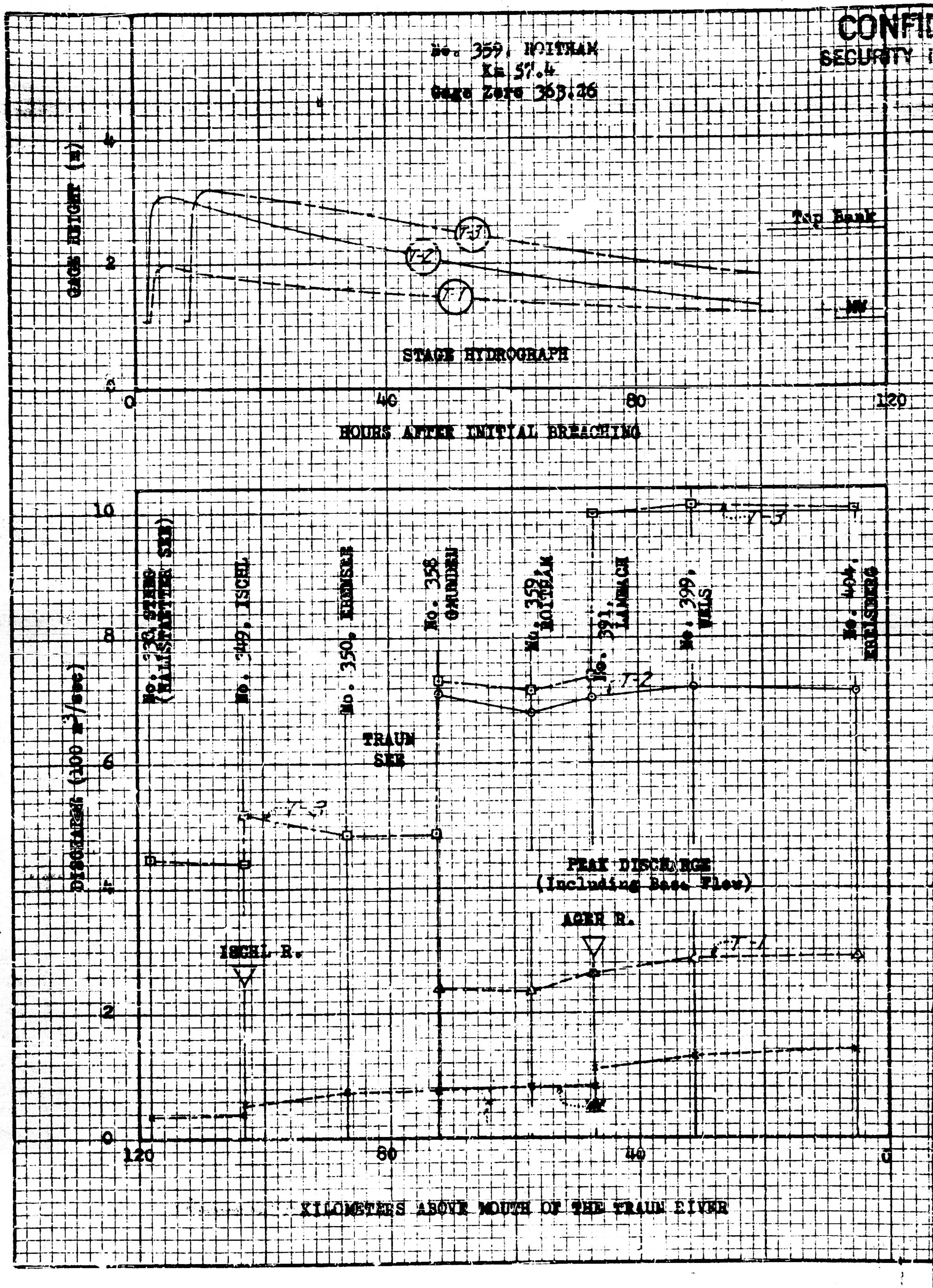


BRUCK IM PINZGAU
STAGE HYDROGRAPH
GAGE HEIGHT (m)
S-1
HOURS AFTER INITIAL BREACHING
LIMBERG DAM
PEAK DISCHARGE (1000 m³/sec.)
BRUCK i. P.
S-1

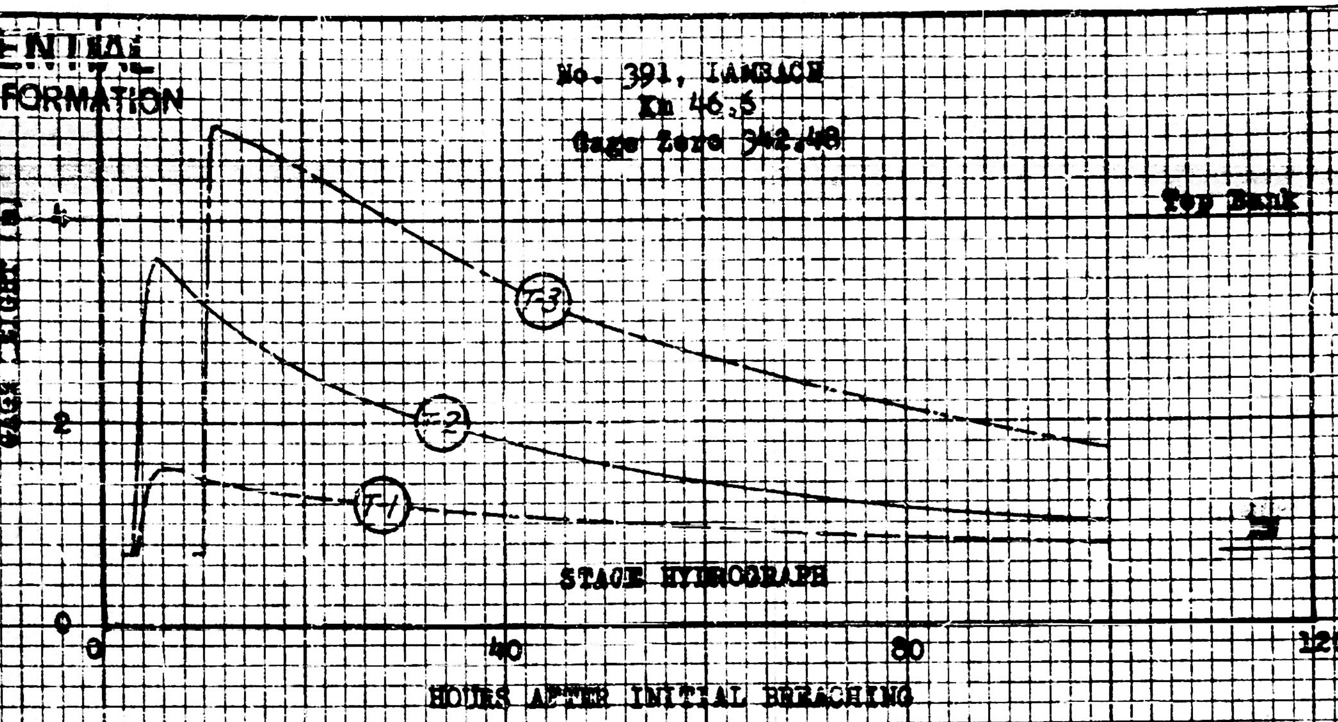


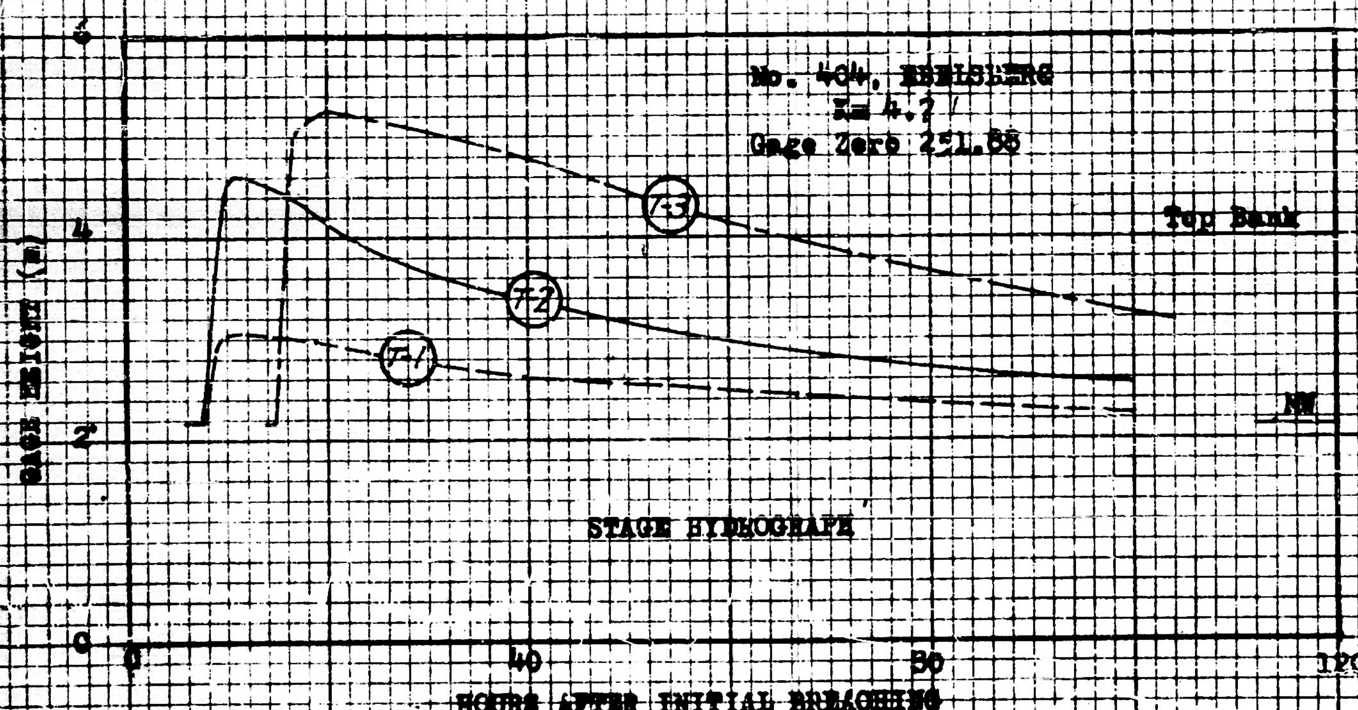
STAGE HYDROGRAPH
GAGE HEIGHT (m)
S-1
0
4
8
12
16
20
24
28
HOURS AFTER INITIAL BREACHING
PROFILE
ACH
80
60
40
20
0
OF THE SALZACH RIVER
CONFIDENTIAL
SECURITY INFORMATION
ARTIFICIAL FLOOD GRAPHS
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT
ENGINEERS
Prepared by
Drawn by
Date

PLATE II b


No. 359, HOITHAM
Km 57.4
Gage Zero 363.26
GAGE HEIGHT (m)
Top Bank
MW
T-1
T-2
T-3
STAGE HYDROGRAPH
HOURS AFTER INITIAL BREACHING
0
40
80
120
DISCHARGE (100 m³/sec)
No. 330, STEEG (HALLSTAETTER SEE)
No. 349, ISCHL
No. 350, EBENSEE
No. 358, GMUNDEN
No. 359, HOITHAM
No. 391, LAMBACH
No. 399, WELS
No. 404, EBELSBERG
TRAUN SEE
ISCHL R.
AGER R.
PEAK DISCHARGE (Including Base Flow)
KILOMETERS ABOVE MOUTH OF THE TRAUN RIVER
10
8
6
4
2
0

FIDENTIAL
INFORMATION





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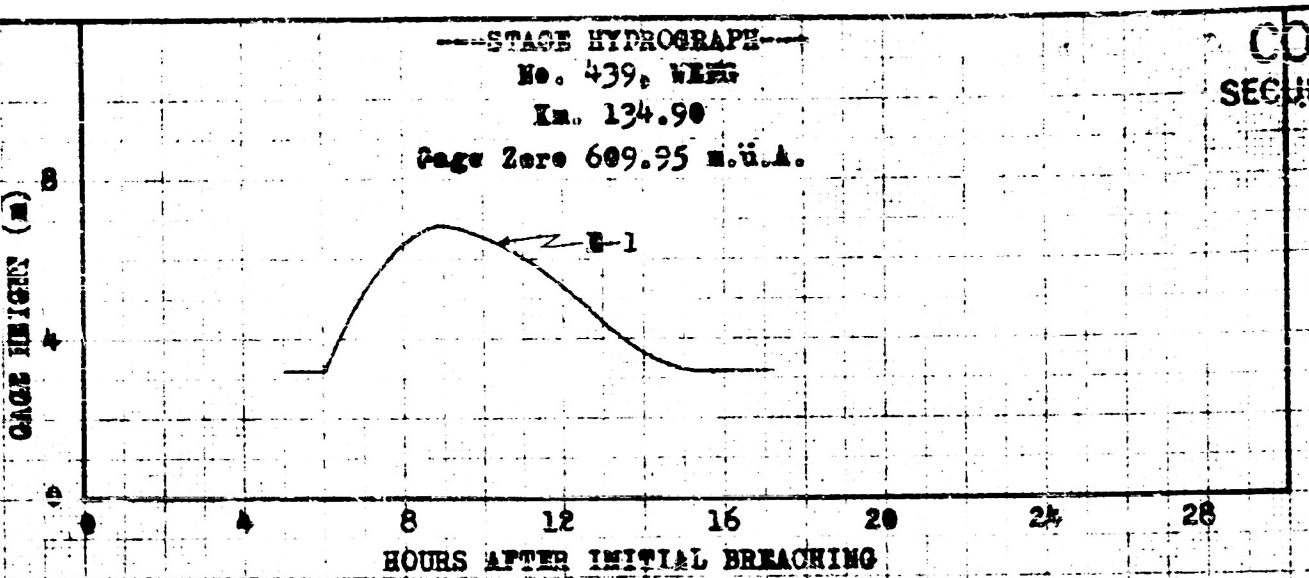
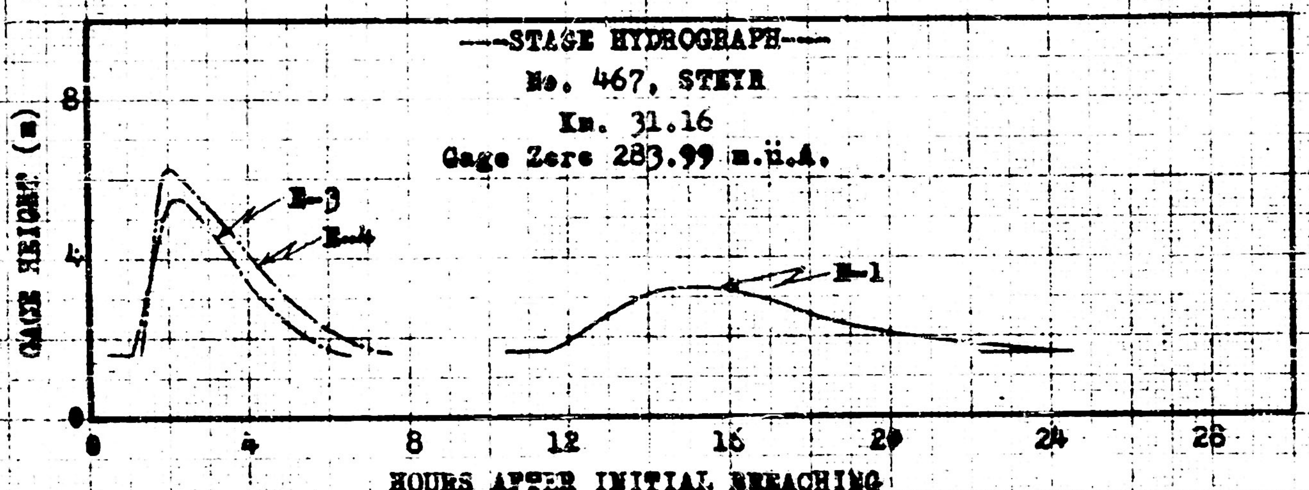
SECURITY INFORMATION

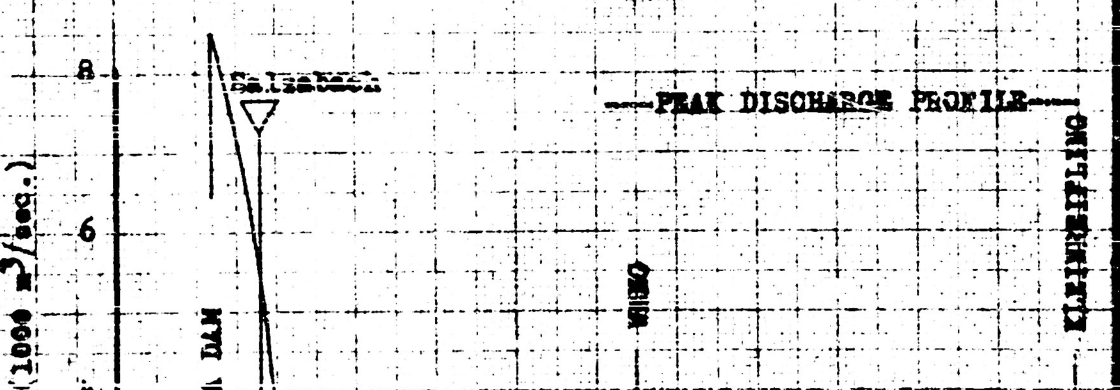
AUSTRIAN ALPS

ARTIFICIAL FLOOD GRAPHS
TRAUN RIVER

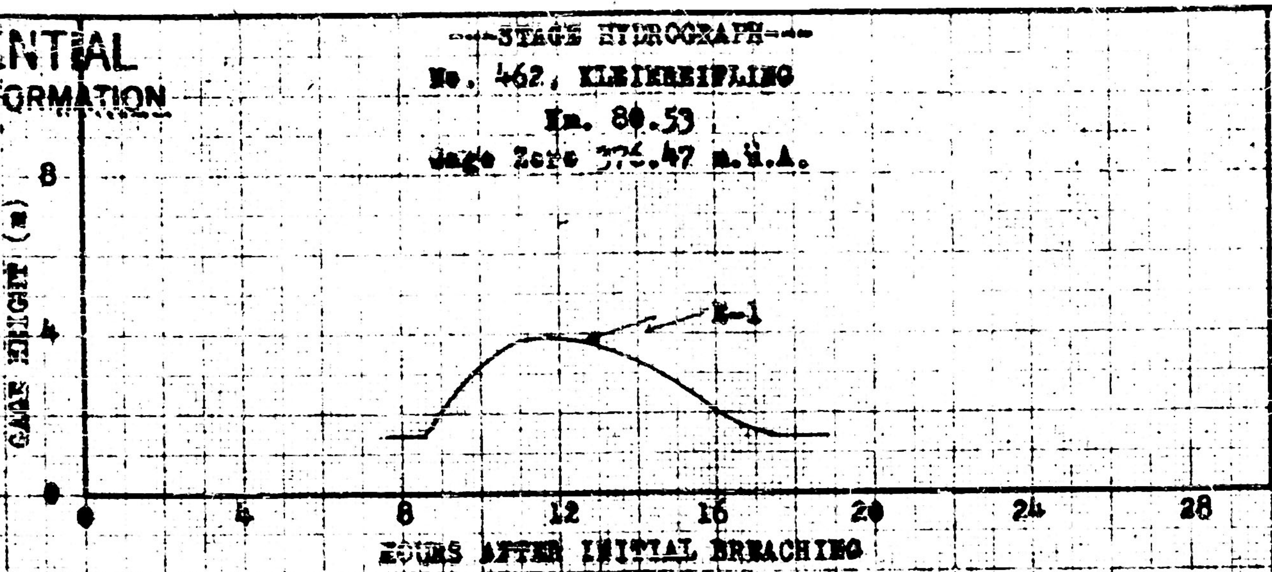
MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by *F.B.S.* Date *Nov 1953*
Drawn by *J.W.H.*

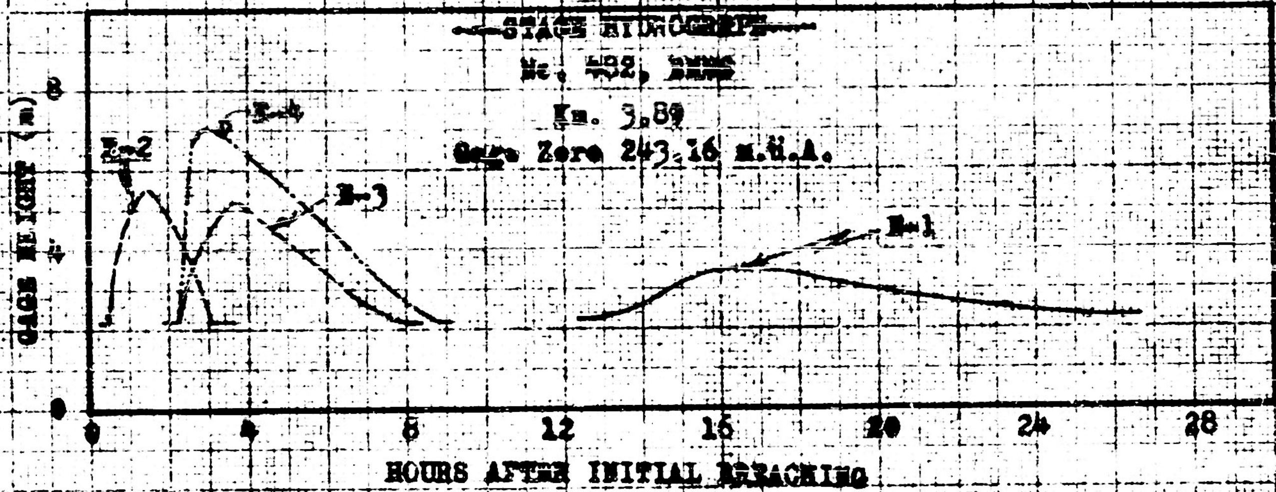

---STAGE HYDROGRAPH---
No. 439, WENG
Km. 134.90
Gage Zero 609.95 m.ü.A.
E-1
GAGE HEIGHT (m)
HOURS AFTER INITIAL BREACHING


---STAGE HYDROGRAPH---
No. 467, STEYR
Km. 31.16
Gage Zero 283.99 m.ü.A.
E-3
E-4
E-1
GAGE HEIGHT (m)
HOURS AFTER INITIAL BREACHING


---PEAK DISCHARGE PROFILE---
PEAK DISCHARGE (1000 m³/sec.)
SALZA DAM
WENG
E-1
HQ
KILOMETERS ABOVE MOUTH

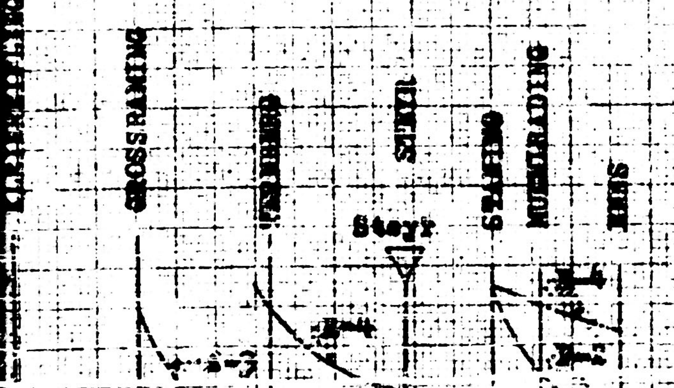
CONFIDENTIAL
SECURITY INFORMATION





NOTES:

E-1 Zero time at breach of Salza Dam.
E-2 Zero time at opening of Staning Weir.
E-3 & E-4 Zero time at opening of Grossraming Weir.



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SECURITY INFORMATION

AUSTRIAN ALPS

ARTIFICIAL FLOOD GRAPHS
ENNS RIVER

MILITARY HYDROLOGY R & D BRANCH
WASHINGTON DISTRICT CORPS OF ENGINEERS
Prepared by JDB Date Nov. 1953
Drawn by JJH

EXHIBIT A

HYDRAULIC DEVELOPMENTS IN THE INN RIVER BASIN

EXHIBIT A

HYDRAULIC DEVELOPMENTS IN THE INN RIVER BASIN

A-01 INTRODUCTION.

a. This exhibit consists of abstracts of technical literature concerning the physical and hydrologic characteristics and the hydraulic developments of the INN River Basin of the AUSTRIAN ALPS. The information was obtained from American, Austrian, German, and Swiss technical literature. The sources are listed according to Reference Numbers cited in the Bibliography following the text in the main body of the report. Primary emphasis in selection of abstracted material was placed upon hydraulic features for use in the study covered by this report. Reference should be made to the cited sources for other critical features, such as structural and electrical factors. Although the information is incomplete in many cases, it is believed that this exhibit would assist in evaluating the military hydrologic potentialities of existing and proposed hydraulic developments in the region. Also it might be used to supplement information from other sources and from field reconnaissance, or to guide further research or intelligence procurement.

b. Specific reference is also made to the general map, Plate 1 of the report; the river basin maps, Plate 2; and to the river profiles, Plate 3, for location of important elements. Data on major hydraulic structures are summarized in Table 5. Serial numbers and river kilometers of hydraulic developments correspond to those shown in Table 5 and on Plate 1. Sketches of the most important typical dam structures used in connection with the artificial flooding studies covered in this report are shown on Plate 9.

A-02 TOPOGRAPHY. (Basis: References 6, 12, 29)

a. The INN River, 518 km long, joins the DANUBE below PASSAU at Km 2226 (as measured from GALATZ on the BLACK SEA). It is the largest North Alpine tributary of the DANUBE, having a drainage area of 26,131 km^2.

b. Originating in SWITZERLAND, the INN flows through territory of AUSTRIA (Province of TIROL) and GERMANY (Province of BAVARIA), serving in places as the international boundary between the latter two countries. This international character of the INN River complicates hydrologic studies because various sources of hydrologic information are involved. Also, international treaties regulate developments for flood control and power utilization in reaches where it forms an international boundary. Between AUSTRIA and GERMANY

(BAVARIA) such treaties have been in existence since 1760. The most recent was signed in MUNICH on 16 October 1950, to take effect 1 January 1951, and defines the distribution of hydroelectric power from newly constructed powerplants. The power development of the INN River near the Austrian-Swiss border is also subject to international negotiations between these two countries.

c. The INN originates in a small lake (PITZ LONGHINO) at an elevation of 2480 m above sea level, located north of MALOJA PASS in the Swiss Canton of GRAUBUENDEN. In its upper reach it forms the lakes of SILS, SILVAPLANA CAMPFER and ST. MORITZ. For 91 km the INN flows through a long valley known as ENGADIN, and drops from 1811 m to 1019 m elevation.

d. At MARTINSBRUCK (Km 416), the INN leaves SWITZERLAND through a 8 km long and very deep ravine (FINSTERMUENZ), and enters AUSTRIA (TIROL). At LANDECK (Km 374), it is joined by the SANNA River, a stream formed by combination of the ROSANNA and TRISSANA, both of which are developed for power production.

e. At LANDECK the INN enters a west-east and west-northeast valley, extending to WOERGL (Km 236), known as the INNTAL. This valley is divided geographically into the OBER INNTAL (Upper Inn Valley), a narrow and high elevated valley that extends to ZIRL (Km 311), near INNSBRUCK, and into the UNTER INNTAL (Lower Inn Valley). The latter portion is wide, with mild side slopes, flat floor and open side valleys. The Austrian INNTAL, combined with the Swiss ENGADIN, forms an approximately 280 km long valley that is the most outstanding geographic feature of the INN River, and represents the longest and most westerly east-west passage through the ALPS. Through it passes all major communication lines (railroads, highways, powerlines, etc.) of the western part of AUSTRIA.

f. Beginning at LANDECK, the INN River has the greatest slope, reaching to 0.35 percent. This diminishes on its course towards the west, but still averages 0.1 percent between INNSBRUCK and KUFSTEIN. In this Austrian part it receives on the right, several streams from the Northern slopes of the ALPS: OETZAL ACHE, SILL, and ZILLER. The INN is being used for raft floating as far as HALL. At KUFSTEIN (Km 219), it breaks through the NORTH LIMESTONE ALPS in a north direction and enters Germany, forming between Km 217 and 204 the international boundary between GERMANY and AUSTRIA.

g. The INN follows a northeast course on the high plateau of BAVARIA with an average 0.097 percent gradient. At Km 187.5 near ROSENHEIM, it receives the MONGFALL River with its tributaries, LEITZACH and SCHLIERACH. At MARKTL (Km 76.5), the INN is joined by the ALZ, a 81 km long river draining Bavaria's largest lake, the CHIEMSEE. The largest tributary, the SALZACH, joins the INN on the right side at Km 67.6.

A-03 GEOLOGY. (Basis: References 6, 12, 21)

a. Between MALOJA PASS and the exit of the INN River into BAVARIA, INN River passes through several geologic formations. The PITZ-LAGREV and PITZ-JULIER group form the northern side of the OBER ENGADIN to SCANF, while the BERNINA-LANGUARD group forms the southern side. The valley widening of SILS and SILVAPLANA lie on Ophiolit between ZERNITZ and ARDETZ on Silvretta gneiss. At ARDETZ (Unter Engadin) the INN enters the Engadin window of Buendner schist. This is very soft and underlies the bed up to PRUTZ (Km 387), in Tirol's UPPER INNTAL. The river breaks through small outcrops of Silvretta crystalline rock and between FLIES and LANDECK through quartzite phyllitic rock.

b. Beginning at LANDECK, the INNTAL is bounded by the limestone NORTH TIROL ALPS on the north and the crystalline CENTRAL ALPS on the south. In parts the limestone formation penetrates farther south. The geologic details of the southern part of the crystalline CENTRAL ALPS are Landeck quartzite phyllitic rock, Oetztal Mass, Innsbruck, quartzite phyllitic rock, and Wildschoenau grey wacke. North of WÖRGL, the INN breaks into the Limestone Alps and at ERL (Km 205), into the ALPINE VORLAND. Tertiary and Quaternary sedimentations appear in many parts of the UNTER INNTAL (LOWER INN VALLEY).

A-04 HYDROLOGY. (Basis: References 6, 12, 29)

a. Because of the Alpine character of the INN River, floods usually appear in summer and low water in winter months. During the investigation of the WASSERBURG powerplant, it was established, based on 100 year averages, that out of 21 flood waters, between 1500-2580 m^3/sec, one occurred in May, 8 in June, 4 in July, 5 in August, and 3 in September. Out of 189 flood waters, between 950-1500 m^3/sec, the following distribution resulted:

January	0	May	17	September	10
February	1	June	64	October	2
March	1	July	60	November	1
April	0	August	32	December	1

b. In the months of November, December, January, February, and March, mean flow does not exceed 150 m^3/sec. Between Km 128-97, the INN'S bed is nearly dry for 240 days a year because of the withdrawal of 340 m^3/sec by the JETTENBACH-TÖGING INNWERK.

c. The currents in the INN River are very swift: 2.0-2.5 m/sec except in reaches impounded by weirs.

d. For several days during December, January, and February, drift ice appears on the INN in addition to ice along the banks. In

the reaches of the INN River dammed by weirs, the surface freezes 7-18 cm deep across the whole river during December, January and February, and occasionally in March. The ice blocs usually pass without causing damage to the banks or hydraulic structures.

e. Regular navigation is not possible on the INN because of its steep gradient, except in reaches upstream of weirs. The river bed consists predominantly of coarse gravel, and partly of flints. Between Km 0.0 and 16.0 appears granite. The depth varies between 2-10 m. The width, because of regulating bank structures, changes only slightly, and varies between 75 m above ROSENHEIM up to 190 m in lower course. (Immediately above the dams in the lower reaches, widths reach as much as 1000 m).

f. The natural flood conditions on the INN River show the most effect in the 67 km reach below the junction of SALZACH River. In most floods, the SALZACH flood wave predominates over the INN flow contribution. Due to the different climatic conditions, the floodwave of the INN never coincides exactly with the flood wave of the SALZACH.

g. The course of the INN downstream from the junction with the SALZACH River, passes into a terrain, suitable for inundation. Here the flow can spread over a wide area and considerable volume of water can be ponded. The storage capacity of this region is increased by the existence of rocky gorges between SCHÄRDING and VORNBACH. These act somewhat like a dam. According to Austrian sources, approximately 50 hm^3 can be accumulated in this natural storage. This results in lowering of flood crest discharges by 200-300 m^3/sec. The flood wave discharge at HHW amounts to 6200 m^3/sec, according to Austrian sources. However, Bavarian sources give 7000 m^3/sec as the HHW flow of 1899 at WERNSTEIN. About 54 hours are needed for the passage of a small flood wave between PERJEN and PASSAU. At HHW the time would be considerably longer.

A-05 WARTIME ARTIFICIAL FLOODING. (Basis: Reference 29)

a. According to the "Mil. Geo. Stromgebiet der Donau, 1937" (Reference 29), the German High Command had the following plan for the exploitation of the INN River flow for warfare purposes. In this plan were involved the four powerplants then in operation on the German territory:

WASSERBURG	Km 160
TEUFELSBRUCK	Km 147
GARS	Km 137
JETTENBACH	Km 128

b. This tactical regulation of the INN River was planned for the reach between the junction with the DANUBE and Km 171, the end of the upper pool of WASSERBURG. The river conditions of 1936 were taken as the basis for the plan.

c. By combined operation of these four hydraulic structures, an artificial flood wave of 2900 m^3/sec discharge of 120 minutes duration could be created by the weir at JETTENBACH. Mean low water (MNW) river conditions with 146 m^3/sec flow were taken as the basis for the calculation. The flood wave would flatten during its flow down the river. It would have 140 minute peak flow of 2200 m^3/sec at the SALZACH Junction (Km 68). At the mouth of the INN River, the flood wave would reach 1700 m^3/sec for 160 minutes. The height of the wave crest at the place of the origin (Km 128) would be 0.25 m over HHW. It would drop to 0.40 m under HHW at the junction of the SALZACH River. Beginning downstream of Km 67.2, the flood wave takes the character of a KHW (small flood).

d. The officer in charge at the JETTENBACH Dam would regulate the inflow by giving orders to the servicing personnel at the other 3 structures. At the same time, by servicing the JETTENBACH gates, he could equalize any irregularities of flow. The idea was to keep the JETTENBACH pool filled as long as possible and let it serve as a kind of equalizing reservoir.

e. The turbine installation on the other three structures would carry the normal flow during this procedure. The diversion canal of JETTENBACH, leading to the powerplant in TÖGING would be closed (one hour before the opening of the JETTENBACH weir) by operating the gates at the surge chamber at TÖGING and also those on the intake structure at JETTENBACH. At the time of passing of the flood wave by the junction of the TÖGING tailrace and the INN River, approximately 86 minutes after its release, the water accumulated in the canal would be released through the turbine or through the waste channel into the INN.

f. The effect of such an artificial flood wave would be similar to damages resulting from catastrophic floodwater and, in many respects, more damaging, particularly in the river reach close to JETTENBACH. Destruction of bridges, highway and railroad and other means of communication cannot be assured. However, the stability of bridges and floodwater dams would be endangered. Ponton bridging would be destroyed. Should the flood wave be released during the period of ice on the river surface, more extensive destruction of all bridges as well as of weirs and powerplants would be quite probable.

g. The effect of the artificial flood wave on the river reach between the SALZACH junction and PASSAU could be compared to the effects of low flood water. Destruction of structures would not take place. However, the crossing of the river by military bridging would be considerably hindered.

h. After the passing of the flood wave, the river would show only limited changes such as erosions, bank breaches, gravel and mud banks, and muddying of inundated areas.

i. The velocities of the wave for the various reaches are as follows:

Km 128 -100	6 m/s
Km 100 - 67	5 m/s
Km 67 - 0	3.3 m/s

j. The magnitude of the artificial flood wave would not be essentially changed if the INN flow would be higher. (up to small flood flow, KTH).

k. Attainment of maximum possible sustained flow of the accumulated masses of water is dependent on the unified control of gate operation. This could be performed most efficiently from the weir at JETTENBACH (R-12). Telephone communication is available for this purpose. The release of the wave was calculated on the basis of velocities given above. Timing is based upon operation of the JETTENBACH Weir, for this instance assumed at 6:00 AM. At this time, all gates of the JETTENBACH Weir will be opened with all possible lifting speed, until 2900 m^3/sec discharge will flow through. This flow will be reached when the lower edges of the gates are 4.95 m above the weir sill. At 5:46 AM, 14 minutes before the opening of JETTENBACH Weir (R-12), the gates at the GARS (R-11), the next weir upstream at Km 137.5, must be opened at its highest possible lifting speed of 0.125 m/min. Similarly, the gates of the second upstream structure, TEUFELSBRUCK (R-10), at Km 147.15, is to be opened at 6:12 AM, and the farthest upstream structure, WASSERBURG (R-9) at Km 160, at 6:31 AM. Both of the latter are to be fully opened. When the pool stage at JETTENBACH Weir begins to drop (approximately at 7:40 AM) the gates of that weir should be fully opened and left in this position until complete emptying of the pool.

l. Such a flood wave could be repeated:

At MNW: 146 m^3/sec after 60 hours
At NW : 360 m^3/sec after 24 hours
At MHW: 1500 m^3/sec after 5 hours
At HHW: 2600 m^3/sec after 2 hours

m. Increased flood wave effect could be achieved by the repetition of the wave and also under special conditions, such as ice flow, wood drift, release of rafts, etc. The effect of the flood wave reduces very sharply as it travels downstream. Blasting of the weir or gates would increase the effect only in the upper river reaches because the water stored by inundation of the downstream flood plains would result in a very rapid decrease of the wave crest.

n. By the operation of the same hydraulic structures, the INN River bed can be also made dry in some places between Km 128 and 67. This period of dry bed could be extended for:

48 hours at MNW - 146 m^3/sec
19 hours at MW - 360 m^3/sec
3.6 at MHW - 1500 m^3/sec
175 hours at HHW - 2600 m^3/sec

A-06 INN RIVER BASIN ABOVE SWISS-AUSTRIAN BORDER (Km 416).
(Basis: Reference 24)

a. Existing Developments.

(1) SILSER (SILS LAKE) Weir. (Serial No. R-1)

This small movable weir regulating the outflow of SILS Lake was constructed in 1947. Pertinent reservoir data are:

Maximum stage elevation	1797.0 m.u.A.
Minimum stage elevation	1796.5 m.u.A.
Storage capacity	2.2 hm^3
Lake area	415 ha

(2) SILVAPLANER (SILVAPLAN LAKE) Weir. (Serial No. R-2)

This small movable weir regulates the outflow of SILVAPLAN LAKE. It was constructed in 1947 for combined power development together with the SILS LAKE Weir. Reservoir data follow:

Maximum stage elevation	1791.00 m.u.A.
Minimum stage elevation	1790.03 m.u.A.
Storage capacity	2.2 hm^3
Lake area	314 ha

(3) ST. MORITZ LAKE Weir. (Serial No. R-3)

This small movable weir regulates the outflow from ST. MORITZ LAKE into the INN River. The combined power development of the three above hydraulic structures is 500,000 KWH per year. Reservoir data follow:

Maximum stage elevation	1768.00	m.u.A.
Minimum stage elevation	1767.1	m.u.A.
Storage capacity	0.7	hm^3
Area of the lake	80	ha

b. Developments in Planning Stage.

(1) SPOELL Development.

The SPOELL River, originates in Italian territory, flows into GRAUBUNDEN Canton and joins the INN River at ZERNEZ, SWITZERLAND. A high dam is planned closing the VALLE DI LIVIGNO, at elevation of 1807 m above sea level. The storage reservoir, thus created, will extend 8 km up to the village of SANTA MARIA and will have 190 hm^3 storage capacity. The work is planned as a combined international power development of ITALY and SWITZERLAND.

(2) SCHULS-TARASP Development.

The project will utilize the reach of the INN River between SCHULS and ZERNEZ by means of construction of a "weir in stream" and powerplant at TARASP.

(3) FINSTERMUENZ Dam and MARTINA LAKE Development.

This development is to be a combined effort of AUSTRIA and SWITZERLAND for exploitation of favorable geologic and hydrographic conditions created by FINSTERMUENZ ravine, through which the INN passes from SWITZERLAND to AUSTRIA. This project provides for a dam at FINSTERMUENZ, 160 m high, which would create a lake, 17 km long. At elevation 1150, the storage capacity at maximum 70 m stage variation, would be 400 hm^3.

A-07 INN RIVER BASIN (Km 416 to KM 218). (Basis: References 25, 27)

a. Existing Developments.

(1) SANNA River and Tributaries Development.

The SANNA River which joins the INN at LANDECK (Km 314), is formed by confluence of the TRISANNA and ROSANNA. The flow of the TRISSANA is impounded by a 14 m long roller weir with 1.1 m head. (Serial No. R-5).

tributaries, the STILLUP BACH and TUXBACH. The drainage area is 1136.5 km^2. The favorable hydrology conditions of the ZILLER valley and possibilities for exploitation of water power contributed greatly to industrialization of the whole area, particularly the lumber industry. According to Reference 6, 359 powerplants were located in the ZILLER River area at the end of 1950, besides many small water supply plants. Only 56 are hydroelectric powerplants. The rest are small primitive types, utilizing water wheels. Some of these originated back more than 200 years. The utilized flow varies between 2.5-200 liter/sec and the power capacity is very low. (For details, see Reference 6, part III 7a). The exception is the so-called MAYERNHOFENER Muehlkanal (Mayernhofen Milrace) between Km 28.2-31.3. This canal redirects 1-1.5 m^3/sec of the ZILLER flow past the ancient fixed dam. This canal feeds 11 small power plant units for various small industrial plants. Tabulation of data on the ZILLER hydroelectric plants can be found in Reference 6. Only two of these 56 hydroelectric powerplants are of more than recent type and are of outstanding importance for the power development of Austria's Province of TIROL. They are the BOESEDORNAU and GERLOS Power Developments.

(b) BOESEDORNAU Power Development.

1. BOESEDORNAU Power Development utilizes the flow of ZEMMBACH, TUXBACH and STILLUP BACH. The development was constructed in the period 1928-31. Originally it was planned together with the developments of ZILLER BACH. This second part was abandoned, but its construction is still under consideration.

2. The three streams have fixed weirs of special construction known as "Tirol Weir," suitable for swift Alpine streams of extreme turbulent character. (See Reference 30, Pages 142, 143 & 155). The "Tirol Weir" is a fixed type without any movable part built so that the swift moving floods carrying iceblocks or driftwood, and large size sedimentary material cannot damage the structure. Along the weir structure extends an open channel approximately 1.5 m wide x 1.5-2.0 m deep, covered only by a trash rack with clearances of 0.006 m. The flow, passing the crest, sinks partly into the channel and partly overflows and falls into the stilling basin placed below the weir. From the channel the flow is carried towards the tunnel and power conduit.

3. The ZEMMBACH intake weir is of the Tirol type, is 23 m long with a crest elevation of 867.5 m.u.A. It has a horizontal intake rack, intake gate, sand removal installation and a fish pass. The weir is constructed to accommodate 440 m^3/sec of catastrophic flood. (See Reference 30, Fig. 67, Page 156.) The free surface tunnel of the ZEMMBACH is 1706 m long, 3.5 m^2 cross-section area, 0.45 percent gradient and 7 m^3/sec maximum permitted flow capacity. At the tunnel entrance is a gravel and sand outlet leading towards the ZEMMBACH stream bed.

4. The TUXBACH is dammed to elevation 882.20 m.u.A., by a concrete "Tirol Weir," equipped with intake rack, intake gate, sand removal installation and a fish pass. The free surface tunnel is 367 m long, 3.5 m^2 cross-section area, 2 percent gradient and 5 m^3/sec maximum permitted flow capacity. The outlet for the TUXBACH tunnel is located 20 m above the ZEMMBACH tunnel and above the combined surge tank, which is at elevation 860.0 with a permissible minimum elevation of 855.0. The 20 m difference in elevation is utilized in the so-called ZWISCHENKRAFTWERK (between Powerplant). The power flow from the TUXBACH tunnel is directed through a penstock to twin Francis turbines with alternating generator of 500 KVA. This ZWISCHENKRAFTWERK is equipped with a waste chute and energy destroyer.

5. The combined installation for TUXBACH and ZEMMBACH utilizes a surge tank equipped with a Buchi sand removal system of 6 chambers. The tank communicates with an open storage basin (11,000 m^3 capacity) equipped with a 60 m long spillway and waste channel 315 m long, 8 percent gradient, leading into the TUXBACH. The intake to the turbines is equipped with a fine rack, a lifting gate 4.20 m x 3.20 m. The inflow is regulated by a butterfly valve, 2.2 m diameter. The steel pipe penstock is designed for 13.4 m^3/sec flow and is composed of the following parts:

512 m long,	slightly inclined	2.2 m diameter
123 m long,	pressure shaft	1.8 m diameter
76 m long,	slightly inclined	1.7 m diameter
129 m long,	very steep	1.7 m diameter

6. The STILLUPBACH development was constructed in the period 1937-39. It impounds the flow of the STILLUPBACH by means of a "Tirol Weir." The 13.0 m long weir has a crest elevation of 870.5. The flow is conducted from the weir into a surge tank through a 280 m long conduit, 3.2 m^2 cross-section area, and 0.25 percent gradient. The maximum permitted flow is 2 m^3/sec. The surge tank is constructed in the form of an equalizing shaft 20 m high, 3 m in diameter, equipped with overflow and regulating mechanism. The penstock, a steel pipe, consists of the following parts:

105 m long,	45 degree incline	1.0 m diameter
20 m long,	horizontal	1 m diameter
275 m long,	very steep open line, anchored at 4 places	0.8 m diameter
77 m long,	ZEMMBACH Valley crossing	0.8 m diameter

where structurally required. The tunnel descends from elevation 1170.25 to 1160.64 m.u.A. Two "window shafts" 345 m and 350 m long respectively, serve for additional intakes. A surge tank consisting of a 39 m high circular shaft, 7.7 m^2 cross-section area. Two upper chambers 138 m long have 1200 m^3 capacity. Three lower chambers have 640 m^3 capacity. The 1394 m long penstock consists of a steel reinforced pipe 2.2 m diameter diminishing to 1.6 m diameter.

5. The powerhouse has 4 Pelton turbines of 21,000 HP coupled with alternating current generators, 10,500 KW and 15,600 KW. The mean utilized flow is 12 m^3/sec, mean utilized hydraulic head 582.7 m. Annual production is 230,000 KWH of which winter (October-March) production is 41,000 KWH, and summer (April-September), 189,000 KWH. The tailrace is a concrete open channel, 260 m long, 5 m wide at bottom, of trapezoidal cross-section, and side slopes 2:3.

6. Further extension of Gerlos Development, which at present is in planning stage according to Reference 33 provides for construction of a dam which would impound the GERLOS flow above the present storage reservoir at elevation of 1390 m.u.A. An annual storage reservoir is to have 40 hm^3 storage capacity. An 8.4 km long tunnel, will transfer the power flow to the powerplant at GMUEND. The tailrace of this proposed powerplant would lead into the present weekly reservoir at elevation 1190 m.u.A.

(5) ACHENSEE Power Development. (Serial No. R-6)
(Basis: References 6, 33, 35, 70)

(a) The ACHENSEE power development utilizes the flow originating in ACHENSEE and its tributaries: AMPELSBACH, ACHENBACH, KRANZBACH, PULVERMUEHLBACH, HEELBACH, DURRACH and KESSELBACH. All these streams including the ACHENSEE, are by nature located within the watershed area of the German ISAR River, a tributary of the DANUBE. However, since the watershed is confined within Austrian territory, the flow is utilized for power development of the Austrian Achensee powerplant and the tailwater from this whole development is diverted into the INN River at Km 269.93.

(b) The north outlet of the ACHENBACH is dammed by a low (0.6 m) weir to elevation 929.45 m.u.A., at the SCHOLASTIKA gaging station. This may be raised up to 929.60. The weir consists of seven openings equipped with stop log closures. Two openings equipped with sluice gates, serve for regulation of the flood water. The HHW of the ACHENBACH is 930.07 m.u.A., which is also the HHW of the lake. The natural storage capacity of the lake in the upper 5 m is 36 hm^3, in the upper 10 m is 66 hm^3. The structure on the south end of the lake, near PERTISAU, consists of an intake shaft 2.6 m diameter, 127 m long and with intake lip at elevation 915.43 m.u.A. The above-mentioned 10 m lowering of the lake stage for power production was set by government regulation in order to preserve the natural condition of the country.

However, much greater lowering may be achieved, from 929.60 to 915.43, corresponding to 14.27 m. Therefore, the volume of storage available for release towards the INN is much higher than the above mentioned 66 hm^3.

(c) A gate regulates the flow into a main pressure tunnel. The sill of the gate has an elevation of 914.94. The intake shaft was sunk into the lake by means of caissons and connected by a drilled tunnel from the land. The entrance into the intake conduit is protected by a movable rack. The pressure tunnel is 4650 m long, 2.75 m diameter and was drilled through limestone and wackas. It has a five percent gradient. The conduit tunnel has a concrete facing. In some part stone masonry and reinforced concrete were required. The inside of the tunnel is surfaced by torkret. The pressure tunnel ends in a cylindrical pressure surge tunnel, 4 m diameter, 40 m high, connecting two chambers. The upper chamber is 80 m long with a 6 x 6 m cross-section area. The lower chamber is 48 m long, 3.9 x 3 m in cross-section. A Venturi meter and butterfly valve is placed between the pressure tunnel and penstock. The penstock is 530 m long, 2.3 m diameter and is strongly reinforced.

(d) The powerplant house, with switch installations, has seventurbines with horizontal shafts at elevation 532.8 m.u.A., coupled directly with generators of the following capacities:

2 turbines, 31,000 hp each, 380 m head
2 turbines, 15,350 hp each, 380 m head
3 turbines, 8,000 hp each, 370 m head

(e) The tailwater canal is 640 m long, open and of trapezoidal shape with concrete sides, slopes of 2:3, and bottom width of 6 m. It carries 25 m^3/sec at 1.7 m depth. The elevation of the canal bottom at the exit from the power plant is 526.12. The canal joins the INN River at km 269.93, by means of a submerged weir. Maximum operation flow of the power plant is 25 m^3/sec and 28 m^3/sec is the maximum intake flow. The watershed of the area is 106 km^2. Mean annual inflow is 140 hm^3; mean inflow rate is 3.3 m^3/sec. The gross hydraulic head of the installation is established as follows:

Maximum permissible stage of the lake	929.60 m.u.A.
The lowest tailwater stage	526.12 m.u.A.
Gross hydraulic head	403.48 m

(f) The AMPELSBACH, a tributary of the ACHENBACH is dammed at Km 2.7 by a "Tirol Weir"; crest elevation 942.5, foot 941.0 m.u.A. The drainage area is 28 km^2, and the flow is 3 m^3/sec. This flow is transferred by a conduit towards ACHEN SEE. The conduit is 7.2 km long, of which 1.8 km is a tunnel drilled through the mountainous range. The rest is open. This conduit receives also the flow of the ACHENBACH by means of pumping.

(g) The ACHENBACH near ACHENKIRCHEN, at Km 15.9, after having left the ACHENSEE towards the north, is impounded by a sluice weir at elevation 898 m.u.A. The watershed area above the weir is 21 km^2. From the upper pool of the weir, the water is transferred by a pumping installation into the AMPELSBACH conduit which brings this flow back into the ACHENSEE. The capacity of this pumping installation is 3.6 m^3/sec, and consists of three centrifugal pumps, each 1.2 m^3/sec capacity. The hydrostatic head overcome by the pumping is 31.7 m.

(h) The DUERRACH with its tributaries, KESSELBACH and UNTERAUBACH, is impounded by a fixed weir, crest elevation 940.0 m.u.A., equipped with a movable shutter, by which flow may be raised to 948.5. The pool storage is 0.25 hm^3; the drainage area is 63 km^2; the mean flow is 3.3 m^3/sec. A Dufour sand removing installation is built on the weir to clear the flow of sand and other material. An 8.2 km long tunnel of 5.5 m^2 cross-section area and 0.15 percent gradient transfers the flow into ACHEN SEE. The flow of the KESSEL and UNTERAUBACH are transferred into the main tunnel by side conduits.

(6) KIRCHBICHEL Powerplant. (Serial No. R-8) (Basis: References 6, 33, 35).

(a) Weir. At Km 232.3, on the INN River, is a concrete movable sluice weir. It has four openings, each 20 m wide, and another 10 m wide opening, the latter for raft floating. The sill elevation of the weir openings is at 491.0 m.u.A., of the raft opening at 494.5. The normal elevation of the upper pool is 496.5; in the winter period the pool is raised to 497.0. The weir openings are closed by double roller gates; the raft opening by a single slide gate.

(b) Canal. The intake structure of the upper water canal adjacent to the main weir, has 10 openings totaling 7.5 m wide, between 9 pillars, each 0.4 m wide. The sill elevation of the structure is 493.0; the bottom elevation below the sluice is 493.75. The canal is 717 m long, of trapezoidal cross-section, 14.64 m wide at the bottom narrowing to 13.75 m at the end of the channel, with side slopes of 4:5. The channel is concrete masonry. The banks are at elevation 498.0. At 125 m distance above the powerhouse, the canal widens to 50.5 m.

(c) Powerhouse. The entrance to the powerhouse and turbines is equipped with a rack and stoplog closure. The powerhouse has three turbine units, with vertical shafts: two each of 7200 KW and one of 3600 KW capacity. The utilized hydraulic head is 7.35 m at full turbine capacity. The maximum flow for power operation is 250 m^3/sec. The net hydraulic head is: 9.84 m at NW, 8.10 m at six months W, and 5.30 m at HW. The waste channel empties into the INN at Km 229.8.

(7) KUFFSTEIN-WEISSACH Power Development.
Basis; Reference 6)

This power development utilizes the flow of the WEISSACH streams by means of a concrete weir with automatic shutter located at WEISSACH, Km 2.6. The upper pool has an elevation of 518.6 m.u.A., the fixed crest of the weir is 517.30 m.u.A. The intake into the power conduit, equipped with rack, has a 40 m long sand removal tunnel, leading into a 208 m long pressure conduit above ground, of 1.6 m diameter. After crossing the SCHWOICHERBACH, the 900 m long tunnel transfers the flow to the powerhouse. The powerhouse is located on the right side of the INN River at Km 222.99. It is equipped with two Francis spiral turbines, each 1000 hp capacity, coupled to an alternating current sychron-generator of 800 KVA. The waste canal is vaulted and 6 m^3/sec capacity, gradient 0.3 percent. The elevation at the junction with the INN River is 480.5. Maximum utilized flow is 2.5 m^3/sec, utilized head is 38 m. In planning stage is an extension of this power plant by impounding of an additional flow of 6 m^3/sec from the WEISSACH by means of 11 m high weir at elevation 566. A small pondage basin of 170,000 m^3 in connection with this extension is also planned.

b. Developments in Planning Stage or Partly under Construction. (Basis: Reference 26).

(1) Upper INN River Power Development.

(a) General. This development extends from the Swiss-Austrian border, crossing the INN River at Km 416.25, and extends to Km 353.5 where the main power plant of ROPPEN will be located. This development will be supplemented by two lateral stages in the KAUNER valley and by the GEPATSCH Reservoir, storage capacity of 100 hm^3. The project is divided into three stages, according to the feasibility and degree of necessity of accomplishment: PRUTZ-ROPPEN, FINSTERMUENZ-PRUTZ, and KAUNER VALLEY.

(b) PRUTZ-ROPPEN Development.

1. Weir. This development is partly under construction. At INN Km 387.2 (3.5 km from PRUTZ) is constructed a movable weir to impound the INN River flow. This sluice weir has a horizontally hinged shutter and a total height of 4 m when closed. It is 90 m long. The upper pool is at 858.5; the fixed weir crest is 854.5 m.u.A. A 2 m lowering of the upper pool stage provides 0.11 hm^3 of stored water, which is being used for small variation of flow. The intake into the conduit is 400 m upstream from the weir. The power conduit is 9.6 km long, 6.2 m diameter and ends in a daily storage reservoir in the PITZ Valley near PITZENHOF. The storage capacity of this reservoir is 1.2 hm^3. The tunnel is drilled through heavy rock composed of landeck phillit, phillit gneiss, mica slate and quartz.

2. The PITZENHOF daily pondage reservoir is created by damming the PITZ Valley by a 26 m high and 160 m long rock fill dam. The dam has a flood water spillway. The normal stage of this reservoir is 856.5; the minimum stage is 842.0, which corresponds to a stage variation of 14.5 m. The difference between the elevation of weir at PRUTZ and the reservoir at PITZENHOF corresponds to the loss of hydraulic head in the conduit at 45 m^3/sec flow. At higher inflows, which may reach 110 m^3/sec during the summer period, the stage of the reservoir may rise up to 848.0. Outflow from the PITZENHOF reservoir is conveyed through a tunnel (6 km long and 6.8 m diameter) to a surge chamber located above ROPPEN. From there two penstocks, each 4 m diameter, conduct the flow to a powerplant located at INN Km 353.5. The powerplant has four Francis turbines, each 29 m^3/sec flow capacity totaling 116 m^3/sec, corresponding to a power capacity of 136,000 KW, at 147 m utilized hydraulic head.

(c) FINSTERMUENZ-PRUTZ Development. The flow of the INN is collected in the pondage basin of FINSTERMUENZ (Km 412) which, with its top stage of 1028 m.u.A., will have a storage capacity of 3 hm^3. A pressure tunnel will lead to the surge tank near PRUTZ, (Km 387.2). The powerplant at PRUTZ is designed for a maximum flow of 88 m^3/sec, 135 m utilized head with installed power capacity of 100,000 KW.

(d) KAUNER VALLEY DEVELOPMENT. In the upper reaches of the KAUNER VALLEY is planned a rock-filled dam, 100 m high which will create a storage reservoir of 100 hm^3 capacity at 1780 m.u.A. The drainage area involved is 103 km^2 plus a 27 km^2 additional area from small tributaries of the FANGENBACH. The 8.2 km long pressure tunnel of 3.4 m diameter will bring the flow into the generating station at FEUCHTEN. The flow capacity is 27 m^3/sec; the utilized head 425-250 m. The tailwater flow from the generating station is to be impounded by a compensating basin of 0.45 hm^3 capacity. A pressure tunnel will lead from the basin to the surge tank above PRUTZ. This pressure tunnel with a net head of 407 m will supply 20 m^3/sec flow to the KAUNER VALLEY Power Station of PRUTZ. The installed capacity is to be 70,000 KW.

(2) OETZ River Development.

(a) General. The power development of the OETZ River and its tributaries is very far reaching. The development is planned in several stages and the construction of the first part started early in 1951. This first stage, to be accomplished in 1958, provides for the construction of the ZWIESELSTEIN storage reservoir with a storage capacity of 122 hm^3, and a power plant at OETZTAL. The second stage of the OETZTAL power developments provides for the construction of two additional dams, as follows:

	Storage Capacity	Elevation	Rate of Flow
FISCHBACH Dam	70 hm^3	2334 m.u.A.	18.6 m^3/sec
RIFFELSEE Dam	30 hm^3	2280 m.u.A.	8-10 m^3/sec

The ultimate stage provides for construction of two more dams, as follows:

	Storage Capacity	Elevation
VENT Dam	120 hm^3	1980 m.u.A.
FINSTERALER Dam	60 hm^3	2340 m.u.A.

(b) ZWIESELSTEIN Dam which is of the arched type has the following dimensions:

Storage capacity	122 hm^3
Area	205 ha
Maximum stage	1575 m.u.A.
Minimum stage	1470 m.u.A.
Net head towards INN River	829 m
Height of the dam above the valley floor	155 m
Length of the crest	370 m
Potential power capacity	233 x 10^6 KWH

The dam site is located at the confluence of the GURGLER ACHE and VENTER ACHE. To a conveying tunnel, 9.4 m long, into which the brooks RETTENVACH and POLLESBACH are diverted, the flow is conducted to the surge tank. From there, it discharges through a pressure tunnel to the turbines of the underground power station BRUGGEN I. The tailwater of this power station, BRUGGEN I, is impounded in the weekly HUBEN reservoir, located in an adjacent valley to the north. At its maximum level of 1233 m.u.A., the storage volume will be 7.5 hm^3. The HUBEN reservoir will serve as compensating basin for the generating stations, BRUGGEN I and II and also as weekly reservoir for the intermediate inflows below the reservoir. A pressure tunnel, 22.4 km long, with the FISCHBACH and HAIRLACHBACH diversion leads from the HUBEN reservoir to the daily reservoir of STUIBENBACH. This reservoir will have a dam 80 m high and a storage net capacity of 2.4 hm^3 at maximum stage elevation of 1230 m.u.A. It will impound the discharge from the OETZ conveying tunnel. From there the water is to be conducted by a pressure tunnel, 1.6 km long to a surge tank, and from there by two penstocks to the OETZTAL power plant. The power station is a fully underground plant. The tailwater is discharged into the INN River by a 1.6 km long canal. The preliminary work for this part of the development was started in the period 1941-45 and work was resumed again in 1951.

(4th opening shut) without raising the upper pool stage of 430.5 mNN. The upper pool of the WASSERBURG Development is protected on both sides by dikes and levees to prevent widespread flooding of low-lying areas. The lengths of these protective structures are 18.4 km. Seven pumping stations, with total capacity of 5.9 m^3/sec, have been constructed for draining of the diked-in areas. Approximately 700 ha which formerly were inundated during the flood period are now protected.

(d) The powerplant is placed in the extension of the weir and perpendicular to the direction of flow. There is no special upper housing structure on the plant. The machine units are protected against weather only by steel cupolas. The powerplant has five turbine units with vertical shafts and generators coupled with the turbines. The total flow capacity of the turbines is 450 m^3/sec (90 m^3/sec each) for 108 days per year and total 24,000 KW power capacity. Annual production varies between 140 and 150 x 10^6 KWH.

(3) <u>TEUFFELSBRUCK Weir and Powerplant.</u> (Serial No. R-10).

(a) Located at Km 147.15, TEUFFELSBRUCK Powerplant has been developed simultaneously with the development of WASSERBURG and the next downstream powerplant at GARS. It was also constructed in 1935-39 as a "powerplant-in-stream." The upper pool elevation is 420.55 mNN. Tailwater elevations are:

At MW 413.23 mNN (MQ = 363 m^3/sec)
At HHW 417.40 mNN (HHQ = 2760 m^3/sec)
At NNW 412.54 mNN (HQ = 75 m^3/sec)

(b) The upper pool has the following dimensions:

Location	Km above Weir	Width (m)	Depth (m)
TEUFFELSBRUCK Weir	0	160	9.8
AU	1	190	8.7
URFAHN	5.5	170	5.9
THALHAM	7.5	170	3.7
KOLBERG	10	170	2.2

(c) The upper pool of TEUFFELSBURG Weir is confined to the INN River bed, on account of the high steep banks. The total length of the structure across the river is 160 m and consists of two parts: the weir and the powerplant.

(d) <u>The weir</u> is movable. It has 4 openings, each 16 m wide and 10 m through-flow height. The weir is able to carry the HHW flow of 2760 m^3/sec through three openings (4th opening closed) without exceeding the upper pool elevation of 420.55 mNN.

(e) The powerplant is constructed, similar to WASSERBURG in an extension of the weir. It has no upper structure and no penstocks. The turbine units built inside the structure are protected on top by steel cupolas. A bridge, 4.5 m, and walkways 1.45 and 1.0 m, on top of the installation provides for crossing of the river and servicing of operating mechanisms. The power plant has 5 conical turbine units with vertical shafts and directly coupled generator. The maximum utilized flow capacity is 450 m^3/sec (90 m^3/sec per unit) for 114 days annually and 24,000 KW power capacity. Annual production is 140-150 x 10^6 KWH.

(4) GARS Weir and Powerplant. (Serial No. R-11).

(a) The GARS powerplant is located at Km 137.5. It was built in the period 1935-1938 simultaneously with TEUFFELSBRUCK and WASSERBURG and is of the same type. The upper pool elevation is 412.40 mNN. Tailwater elevations are 405.20 at MW, 408.95 at HHW, and 404.06 at NNW. The upper pool dimensions are:

Location	Km above Weir	Width (m)	Depth (m)
GARS Weir	0	180	9
TAHL	–	260	7.5
GARS	3	150	6.6
GUSCHSTALL	–	150	5.7
HOCHLEITEN	8.5	130	3.0

(b) The backwater extends 9.0 km upstream to Km 146.5 nearly to the TEUFFELSBURG Weir. The total length of the structure across the INN River is 180 m. The weir has 4 openings, each 17 m wide and 9.0 m through-flow height. These are exactly the same dimensions as at WASSERBURG. Here, also, the openings are dimensioned for HHW flow of 2,600 m^3/sec. This high flow can be carried by three openings (one opening closed) without raising the upper water elevation above 412.4 mNN. The upper pool (similar to that at TEUFFELSBURG) is confined by high banks to the INN River bed, and no protection of banks against inundation was necessary.

(c) All information with regard to the powerplant part of the development is exactly the same as in the case of WASSERBURG and TEUFFELSBRUCK. This applies to turbine units, utilized flow power capacity, power production as well as to bridge crossing, portal crane, etc. There are 5 KAPLAN turbine units, vertical shafts and generators directly coupled. The maximum flow capacity is 450 m^3/sec, 115 days annually, 24,000 KW power capacity – 150 x 10^6 KWH annual power output.

(5) JETTENBACH-TOEGGING Powerplant. (Serial No. R-12).
(Basis: Reference 47)

(a) This development is the oldest on the German part of the INN River, having been constructed in the period 1919-1924. It is located between Km 128.0-95.0. The movable weir at JETTENBACH, Km 128.00, impounds the flow of the INN River at 403.00 mNN, which is 6.50 m above

the MW elevation of 396.5 mNN. The backwater of the weir is 8.4 km long and reaches to Km 119.6, with the following dimensions:

Location	Km above Weir	Width (m)	Depth (m)
JETTENBACH Weir	0	140	9
FRAHAM	2	170	6.3
O. MOEDLING	4	151	5.2
BINDER	6	177	3.0
MITTERGARS	8.5	86	2.6

(b) The weir has 6 openings, each 17.0 m clear width and 8.5 m through-flow height. The sill of the weir openings is at elevation 394.5 mNN. (See sketch of dam on Plate 9a). The total length of the weir structure is 122 m, and carries a bridge crossing, with a 4.0 m wide roadway. The weir rests on caissons, sunk 20-30 m under the riverbed on flint rock. The weir openings are closed by double sluice gates, 6.20 and 2.30 m, which may be lifted independently on rollers, moving in niches on the sides of the piers. In front of the gates there is a stoplog emergency closure. (See Reference 36, Page 637).

(c) The flow from the upper pool of the JETTENBACH Weir is diverted into a 20 km long canal leading to the powerplant in TOEGGING. The intake into the canal, located on the left side of the INN River, and nearly at right angles to the weir, consists of 21 openings, each 5.6 m wide and 4.5 m high, equipped with sluice gates. (See Figure 880, Page 584, Reference 36). The sill elevation is 398.50 mNN. The canal is of trapezoidal section, 5.8 to 10 m deep, 37.6 up to 50.7 m wide at the water surface, and 8.75 to 33.3 m wide at the bottom. It has 220 to 250 m^2 cross-sectional area and carries 300 m^3/sec at 1.4 m/sec velocity. (See Reference 36, Page 77, Fig. 1260E). Its gradient is 0.0159 percent. In places, the canal cuts 18 m deep through the terrain.

(d) This canal ends in a basin 120 m wide located on top of the natural terrain grade near TOEGGING. The basin level is at elevation 398.80 mNN in summer, 402.45 mNN in winter. At the foot of this grade is the powerhouse. The flow capacity utilized for power production is 300-340 m^3/sec at 31.5 m utilized hydraulic head. The widened canal communicates with the surge chamber from which the flow is carried to the turbines by 15 forged-steel pipes, of 4.0 m clear diameter, and 50 m length. In the case of sudden stoppage of machines, a side syphon installation communicating with bottom outlets can divert 150 m^3/sec directly into a tailrace over an energy dissipator. (See Figure 1561, Page 920, Reference 36). The tailrace at elevation 369.18 mNN in summer and 368.20 mNN in winter, is 2.8 km long and empties over a depressed weir directly into the INN River.

(e) The powerhouse contains 15 Kaplan turbine units, each 27 m^3/sec flow capacity. Seven of these generate direct current (6000 KW capacity each), and eight generate alternating current (5800 KW capacity, 8200 KVA each).

(6) <u>NEUOETTING Powerplant (Serial No. R-13)</u>.

(a) This plant was constructed in the period 1947-1951, as a "powerplant-in tream" similar to those at WASSERBURG, TEUFFELSBURG, and GARS. The flc capacity of this plant is 510 m^3/sec, 94 days per year, 24,000 KW power capacity and 150 x 10^6 KWH annual power output. The upper pool stage is 368.80 mNN. The tailwater elevations are:

MW 361.46 mNN (MQ = 371 m^3/sec)
HHW 367.35 mNN (HHQ = 3000 m^3/sec)
(NNQ = 80 m^3/sec)

(b) The weir has 5 openings, each 18.0 m wide, with 8.50 m flow height. Roller gates with collapsible hinged shutters on top are provided.

(7) <u>LEITZACHWERK Power Development</u>.

(a) The LEITZACH Power Development uses the flow of the MONGFALL River, its tributary LEITZACH and SEEHAMER Lake, serving as annual storage reservoir, of the following dimensions:

Maximum elevation	654.00	mNN
Minimum elevation	646.00	mNN
Storage	5	hm^3
Area	1180	ha

(b) The MONGFALL flow is impounded near WALL and transferred by a tunnel into SEEHAMER LAKE, after crossing SCHLIERACH River by an aqueduct and receiving its flow. A pressure tunnel leads the SEEHAMER LAKE outflow to surge tank and from there by penstock to powerplant at VAGEN. The tailrace joins the MONGFALL.

b. <u>Developments in Planning Stage</u>.

The seven powerplants which are at present in planning stage on the German part of INN River will be all of the same type as WASSERBURG, TEUFFELSBRUCK, GARS and NEUOETTING. When constructed, the full exploitation of the INN River in this part will be achieved. See Table A-II following the text of this exhibit for tabulation of pertinent data. The planned "powerplants-in-stream" are:

(1) <u>OBERAUDORF Weir and Powerplant (Km 211.00)</u>.

This is a power development planned on the reach of the INN River that forms an international boundary between AUSTRIA and BAVARIA (Km 217.61-204.3). The INN will be impounded to elevation 472.5 mNN. The structure will be able to carry 1950 m^3/sec the HHW flow. The average flow is 308 m^3/sec at a gross head of 6.6 m. The powerplant will be constructed for 440 m^3/sec, with a power capacity of 20.50 KW, and annual production 111 x 10^6 KWH.

(b) The development is built as a "powerplant-in-stream" similar to the other existing INN River plants like WASSERBURG. The weir has 6 openings, each of 8.0 m clear width and 12.0 m through-flow height. The HHW flow of 6000 m^3/sec can be carried by five openings (6th opening closed) without raising the upper water elevation of 336.2 mNN. (See dam sketch on Plate 9a). For closure of weir openings, there are double sluice gates composed of two vertical sliding leaves. The upper leaf is equipped with a hook-shaped upper crest. The gates are operated by a power drive on both ends. For the installing and servicing of the weir facilities, in particular for installing the stoplogs on emergency closures as well as for servicing of powerhouse, there is provided a cantilever crane of 270 T loading capacity.

(c) The backwater pool of the INN River, with 8.25 km^2 of surface area, is protected by 10 km long dikes on the left bank. The protected area on both sides of INN are drained by means of 2 pumping works. A further extension of bank protective structures near TAHL has been carried out in connection with the building of the powerplant at BRAUNAU.

(d) The powerhouse of the ERING Development has three Kaplan turbines with vertical shafts and superimposed generators. The maximum flow capacity of each is 340 m^3/sec at a utilized hydraulic head of 10.18 m, representing 34,000 HP power capacity. The turbines have 7 m diameter and are the largest turbines used in GERMANY. The average flow of the INN at this place is 715 m^3/sec; the average annual production of power is 427×10^6 KWH.

(2) <u>OBERNBERG (EGGLFING) Weir and Powerplant. (Serial No. R-16)</u>.

(a) The OBERNBERG power development is located at Km 35.3. It was constructed in the period 1941-1944 simultaneously with ERING as a "powerplant-in-stream" type similar to all other power plants on the INN River. The weir impounds the flow of the INN River to elevation 325.9 mNN. The backwater reaches for a distance of 10 km upstream into the tailwater of ERING Development. The weir has 5 openings, each 23 m wide, and of 13.5 m through-flow height. The HHW of 6300 m^3/sec can pass through the weir openings without raising the upper water elevation of 325.9 mNN. On the tailwater side of the weir is a covered bridge which accommodates cables and other servicing installations. For closure of the weir opening, there are double sluice gates with hook-shaped upper crest on the upper leaf, similar to those at ERING. The weir as well as the powerplant part of the development is equipped with stoplogs for upstream as well as downstream emergency closures. For servicing of the whole installation, there are 2 portal cranes. The powerhouse has 6 machine units and 3 generators working in twin arrangements so that only 3 transformers of 32,000 KVA are needed.

(b) The powerplant is built for a maximum 990 m^3/sec flow at 9.85 m utilized hydraulic head, which represents 80,000 KW power capacity. The average flow of the INN amounts to 721 m^3/sec; the gross head of the structure is 10.2 m.

(c) The upper pool region of the OBERNBERG Weir is protected on the Bavarian side by a protective dike 10 km long. On the Austrian side the protective structures extend 5.6 km from GRABEN to the junction of the ACHEN. The land behind the right bank dike is drained by pumping works. The left side area is drained through the existing channel communicating with the tailwater of the OBERNBERG installation.

c. Developments Under Construction.

(1) BRAUNAU (SIMBACH) Weir and Powerplant. (Serial No. R-14).

(a) The flow of INN River is impounded to elevation 348.5 mNN at Km 61.1, 2.7 km upstream from the town of BRAUNAU. The total length of the structure across the INN River is 320 m. The weir part consists of five openings each 23 m wide and 13.5 through-flow height. They are equipped with double sluice gates with hoists installed upon the piers. A traveling crane servicing the weir and powerhouse moves on a bridge crossing the whole structure. The HHW flow is 5600 m^3/sec.

(b) Levees to prevent floods were built along the reservoir area on both banks of the river. On the Bavarian side the length of the flood protective structure is 13.5 km, on the Austrian side 8.5 km. For draining of diked-in areas, there is one pumping plant on the Austrian side and two pumping plants on the Bavarian side.

(c) The powerhouse has four Kaplan turbines each 22,700 KW and four generators of 32,000 KVA. The powerplant is designed for 1020 m^3/sec flow capacity at 11.5 m utilized hydraulic head. The average flow is 715 m^3/sec and the gross head 11.5 m. Construction started in 1951; completion is planned for 1953-1954.

d. Developments in Planning Stage.

(1) SCHAERDING Weir and Powerplant. (Serial No. R-17)

(a) This power development is planned to be located at Km 17.7 above the junction of the ROTT Stream. The design of the structure is of the same type as the other INN River "powerplants-in-stream."

(b) The flow of INN is impounded to elevation 314.5 mNN. The powerhouse part of the development is on the right bank because of low lying terrain on the Bavarian side. The left side will be protected by a continuous levee extending from the weir in SCHAERDING up to the tailwater of the power plant in OBERNBERG. On the Austrian side, only short levees including pumping works for draining of low located areas will be necessary.

(c) The utilized flow of the development is 1015 m^3/sec. The average flow here is 733 m^3/sec ad gross head is to be 10.95 m. The HHW flow reaches 6500 m^3/sec at this location. The development is planned for 85,000 KW power capacity with annual production of 504 x 10^6 KWH.

(2) PASSAU Weir and Powerplant. (Serial No. R-18)

The PASSAU powerplant is the last step in hydroelectric utilization of INN River on the German-Austrian boundary to be developed by Oesterreichische Bayeirische Kraftwerke A.G., and will be located at Km 4.2 in the "break-through" valley, by which the INN River enters the plains of the DANUBE. The flow is to be impounded to elevation 302.5 mNN. The weir will be designed to accommodate the HHW flow which here reaches 6800 m^3/sec. The average flow of the INN is 747 m^3/sec. The gross head will be 10.05 m. The powerplant is to be constructed for 1020 m^3/sec flow capacity. The maximum power capacity will be 76,000 KW, annual production 469 x 10^6 KWH.

A-10 ALZ RIVER (Basis: References 36, 37, 50, 51, 52).

a. General.

(1) The ALZ River, the largest and most important German tributary of the INN River is the natural outflow of the largest Bavarian Lake, CHIEM LAKE. The stream is characterized by abundant flow because of its CHIEM LAKE origin, very steep gradient and nearly complete absence of detritus. The ALZ is 81 km long. It flows from SEEBRUCK, elevation 518.11 mNN, (which is also the location of the CHIEM LAKE outlet) to its junction with the INN River at MARKTL, elevation 358.00 mNN. Flow statistics at SEEBRUCK are as follows:

HW 60 m^3/sec
MW 24 m^3/sec
NW 9.5 m^3/sec

(2) The ALZ River was one of the first German streams developed for the power requirements of the electrochemical industry in this region. The development of the river for this purpose started in 1909 and finished in 1923.

(3) The upper ALZ, that part of the river between CHIEM LAKE and ALTENMARKT, is 18.4 km long, very winding (the aerial distance being only 9 km) and has a 31.5 m/km gradient. This reach is undeveloped at the present time, although development would be most desirable. The geological formation of the UPPER ALZ bed and its great seepage are under extensive study in order to make the exploitation of this part of ALZ River possible. (See Reference 52, Page 94)

(4) Between ALTENMARKT and the junction with the INN River at MARKTL, the ALZ River is developed for power production in 4 stages, as follows:

ALTENMARKT - FROSTBERG
FROSTBERG - TACHERTING
TACHERTING - MARGARETHENBERG
HIRTEN - HOLZFELD - BURGHAUSEN

b. ALTENMARKT-FROSTBERG Power Development. (Serial No. R-19).

This development was constructed in the period 1909 to 1911. A weir 1.5 km upstream from FROSTBERG, impounds the water of the ALZ River at elevation 488.67 mNN. The impounded water is directed into a left bank diversion canal leading towards the powerplant at the city of FROSTBERG. The hydraulic head utilized by this powerplant is 5.00 m. The power capacity of the plant is 2500 HP.

c. FROSTBERG-TACHERTING Power Development. (Serial No. R-20).

This development was built simultaneously with the FROSTBERG powerplant in the period 1909-1911. The ALZ flow is impounded at elevation 480.17 mNN near FROSTBERG and diverted by a 5.5 km long left bank open canal to the powerplant located approximately 1.5 km upstream from TACHERTING. The head utilized at this plant is 18 m. The power capacity is 18,500 HP. The mean and utilized power capacity is 9100 HP. (See Reference 50).

d. TACHERTING-MARGARETHENBERG Power Development. (Serial No. R-21).

This power development was started in 1916 during World War I, and was placed in operation in 1920. This power development utilizes the 37 m fall of the ALZ River betweenTACHERTING and MARGARETHENBERG. The flow of the ALZ River is impounded downstream from TACHERTING by a movable weir and diverted to a 13.5 km long canal situated on the left bank leading to the powerplant at MARGARETHENBERG. The canal empties first in a surge basin and from there is transferred to the powerhouse. The power capacity of MARGARETHENBERG powerplant is 22,000 HP; the mean annual capacity is 18,500 HP.

e. HIRTEN-HOLZFELD-BURGHAUSEN Power Development. (Serial No. R-22).

(1) This power development was constructed in the period 1919-1923. The intake from the ALZ River is located a short distance downstream from MARGARETHENBERG. The weir is 84.18 m long, the crest elevation 423.5 mNN. The ALZ flow is diverted into a 16.0 km long canal, located on the right bank. The canal crosses the watershed of the ALZ and ends in the SALZACH River after passing through the HOLZFELD-BURGHAUSEN powerplant. The intake installation for the canal is developed in such a way that the canal flow can be taken directly out of ALZ River or from the tailwater outflow from the MARGARETHENBURG powerplant (See Figure 1-3, Page 462, Reference 50).

(2) The MARGARETHENBURG powerplant and its tailrace is located on the left bank of the ALZ. Its tailrace elevation varies between 419.10-420.10 mNN, at 2.5 m depth. In order to reach the power canal of HOLZFELD-BURGHAUSEN, the waste water of MARGARETHENBURG powerplant has to cross the ALZ River. This is accomplished by means of a syphon installation located inside the intake weir structure. The lowest point of this syphon installation is 11 m below the crest of the weir reaching elevation 412.5 mNN. The tailwater flow of the MARGARETHENBURG powerplant into the syphon and into the BURGHAUSEN canal is regulated by a gate.

(3) The HOLZFELD-BURGHAUSEN supply canal from the intake at HIRTEN to the powerhouse is 16 km long (See Reference 36, Page 669. The canal is of trapezoidal cross-section, 3.5 m width at the bottom, 16 m maximum width and 4.5 m depth. Cross-section area is 46 m^2, flow velocity 1.3-1.5 m/sec, flow capacity 60-70 m^3/sec, and gradient 0.018 percent. The canal runs along the ALZ River to BURGKIRCHEN partly above the surrounding terrain and partly cut below the terrain. It crosses the railroad at BURGKIRCHEN by a syphon installation. A relief structure, withdrawing up to 30 m^3/sec of flow towards HALSBACH, is located at this place. The canal passes through a 1.5 km long tunnel. At HINTER MEHRING the canal leaves the watershed area of the ALZ River and crosses into the SALZACH area to reach the HOLZFELD-BURGHAUSEN powerplant.

(4) The surge tank of the powerplant is equipped in the usual manner. It has 5 turbine intakes, an emergency spillway 15 m long, and a fine rack. It also has 2 waste conduits, 175 m long, 3.0 m diameter and 60-70 m^3/sec capacity (See Ref. 51, Page 722, The penstock consists of 5 pipes, 2.6 m diameter, 0.010-0.016 m thickness. The power flow varies from 20 to 60 m^3/sec; the mean annual flow is 45.5 m^3/sec. In addition, 10 m^3/sec are being used for other purposes. The gross hydraulic head of the development is 59.35 to 64 m, mean annual head 63.6. Utilized head is 57 to 61.8 m, and mean hydraulic head 61.4 m. Five Francis turbine units with horizontal shafts, 28,000 HP, provide for power generation.

TABLE

Existing Power Developments on the INN Rive[r]

Nr 217161

Name of the Development Serial No. (1)	River Km	Watershed Area km^2	Upstream Stage mNN	Head: Without Downstream Damming (At NNW / At MW / At HHW)	Head: With Damming	Discharge m^3/sec (NNW / MW / HHW)	Weir (Nu[mber] Wi[dth] Flow)
1	2	3	4	5	6	7	
WASSERBRUECK R-9	159.9	11,993	430.50	7.95 6.78 2.75	- - -	75 362 2760	
TEUFELSBRUECK R-10	147.2	12,060	420.50	- - -	7.97 7.27 3.10	75 363 2760	
GARS R-11	137.5	12,210	412.50	8.44 7.25 3.55	- - -	76 365 2760	
JETTENBACH-TOEGGING R-12	127.96 95.00	12,250	403.60	34.39 30.62 26.14	33.62 30.45 27.23	76 365 2800	
NEUOETTING R-13	91.1	13,150	368.80	8.60 7.34 1.45	6.77 6.36 1.18	80 371 3000	
ERING R-15	48.0	23,390	336.20	- - -	10.22 9.65 4.10	184 715 5000	
OBERNBERG (EGGLFING) R-16	35.3	23,740	325.90	12.36 10.85 4.70	11.32 10.22 4.50	189 722 6300	

(1) Serial number used in report-See General Map, Plate 1
(2) Paragraph number of Exhibit A in which description contained
(3) Kaplan units designated by "K", Francis units by "F"
(4) Source: Reference 4

River between KUFSTEIN and PASSAU

...51 - 2.55

Weir Openings Number Width Flow Height	Turbine Units No. of Units (3)	Flow Capacity m³/sec days per year	Power Capacity KW	Mean Annual Output KWH x 10^6	Remarks (2)
8	9	10	11	12	13
4 17.0 9.00	5K	465 108	24,000	140	Powerplant-in-Stream on right bank See A-08a(2)
4 16.0 10.00	5K	450 114	24,000	148	Powerplant-in-Stream on left bank See A-08a(3)
4 [illegible] 9.00	5K	450 115	24,000	150	Powerplant-in-Stream on left bank See A-08a(4)
6 17.0 8.50	15F	540 150	84,000- 85,000	560-575	20 km long canal on the left bank diverts the flow to powerplant at TOEGGING. See A-08a(5)
5 18.0 8.50	3K	510 94	21,000- 24,000	132-150	Powerplant-in-stream on right bank See A-08a(6)
6 [illegible] 12.00	3K	1020 82	72,500	427	Powerplant-in-stream on left bank See A-09b(1)
5 23.0 12.50	6K	900 89	80,000- 84,000	468-495	Powerplant-in-stream on left bank See A-09b(2)

PREPARED BY: MILITARY HYDROLOGY R&D BRANCH
WASHINGTON DISTRICT, CORPS OF ENGINEERS
NOVEMBER 1953

Power Developments on the INN River
Under Construction or
Km 217.61

Name of the Development Serial No. (1)	River Km	Watershed Area Km^2	Upstream Stage mNN	Head: Without Downstream Damming At NNW / At MW / At HHW	Head: With Damming	Discharge m^3/sec NNW / MW / MHW	Weir … Nu… Wi… Flow…
1	2	3	4	5	6	7	
OBERAUDORF	211.0	9,700	472.50	- - -	7.27 6.58 2.79	61 308 1950	4 16 8
WINDSHAUSEN	204.0	9,850	465.10	- - -	7.25 6.55 2.23	62 313 1950	4 16 8
NEUBEUERN	195.6	9,935	457.70	- - -	7.32 6.68 2.65	63 315 1980	4 16 8
ROSENHEIM	187.5	10,000	450.30	- - -	9.37 7.58 4.20	64 318 2010	4 16 9
FELDKIRCHEN	173.1	11,330	440.00	- - -	9.48 8.34 4.63	71 354 2500	4 18 9
PERACH	83.0	13,370	362.00	- - -	6.76 5.93 1.28	84 377 3000	[illegible] 18 9
STAMMHAM	75.4	15,730	355.10	- - -	6.56 6.20 1.65	86 382 3300	[illegible] 18 9
BRAUNAU R-14	61.1	22,700	348.50	- - -	12.22 11.50 5.90	170 697 5600	[illegible] 2 1
SCHAERDING R-17	17.7	24,360	314.50	- - -	11.76 10.95 2.80	198 733 6500	[illegible] 2 1
PASSAU R-18	4.2	26,075	302.50	11.88 10.04 0.90	- - -	213 747 6800	2 1

See Table A-I for footnotes

...E A-II

...ver between KUFSTEIN and PASSAU
...in Planning Stage
... 2.55

...ir Openings Number Width ...low Height	Turbine Units: No. of Units (3)	Turbine Units: Flow Capacity m³/sec days per year	Turbine Units: Power Capacity KW	Turbine Units: Mean Annual Output KWh x 10⁶	Remarks
8	9	10	11	12	13
4 16.0 8.00	3K	440	20,500	111	Powerplant-in-stream on left bank See A-08b(1)
4 16.0 8.00	3K	440	20,500	111	Powerplant-in-stream on left bank See A-08b(2)
4 16.0 8.00	3K	440	21,000	114	Powerplant-in-stream on left bank See A-08b(3)
4 [illegible] 9.00	3K	440	23,500	132	Powerplant-in-stream on right bank See A-08b(4)
4 18.0 9.00	3K	510	29,500	173	Powerplant-in-stream on left bank See A-08b(5)
5 16.0 9.00	3K	510	21,500	127	Powerplant-in-stream on right bank See A-08b(6)
5 18.0 9.00	3K	510	23,000	134	Powerplant-in-stream on left bank See A-08b(7)
5 23.0 13.50	4K	1016	90,000	515	Powerplant-in-stream on right bank See A-09c(1)
5 23.0 13.5	4K	1015	85,000	504.	Powerplant-in-stream on right bank See A-09d(1)
5 23.0 13.50	4K	1020	76,000	469	Powerplant-in-stream on left bank See A-09d(2)

TABLE A-II

[illegible]

EXHIBIT B

HYDRAULIC DEVELOPMENTS IN THE SALZACH RIVER BASIN

EXHIBIT B

HYDRAULIC DEVELOPMENTS IN THE SALZACH RIVER BASIN

B-01 INTRODUCTION.

This exhibit consists of abstracts of technical literature concerning the physical and hydraulic characteristics and the hydraulic developments of the SALZACH River Basin of the AUSTRIAN ALPS. Reference is made to paragraph A-01 of Exhibit A for discussion of the source material and other reference data.

B-02 PHYSICAL AND HYDRAULIC CHARACTERISTICS.

a. General. The SALZACH River originates on the slopes of SALZACH GEIERKOPF at elevation 2300 m.u.A. It flows through a small lake, SALZACH SEE, at elevation 2280 m.u.A. Shortly afterwards, it joins with the KRIMMLER ACHE. From there, up to the junction with the INN River, the SALZACH is 212 km long with a 564 m total fall. The total length of the SALZACH River is 224 km. The drainage area is 6733.7 km^2, of which 156.3 km^2 are glaciers. Morphologically the course of the SALZACH can be divided in two major parts:

(1) UPPER SALZACH between Source (Km 224) and GOLLING (Km 93.6)
(2) LOWER SALZACH between GOLLING and Junction with INN (Km 0)

b. UPPER SALZACH (Km 224.0 - 93.6).

(1) Topography. The upper course of the SALZACH River to GOLLING is located in the high Alpine region of the Austrian Province of SALZBURG. In this part it flows through an 80 km long longitudinal valley known as PINZGAU, followed by a 30 km long south-north cross-valley known as PONGAU. Four distinct geologic and topographic regions are noticeable in this part of the SALZACH course. Description of each region is contained in the following subparagraphs.

(a) Beginning at KRIML (Km 212), and as far as BRUCK-FUSCH (Km 161.4), the SALZACH flows in a west to east direction through a wide and partly marshy trough-shaped valley, with a wide flat floor known as OBERPINZGAU. The side valleys accommodating the SALZACH'S numerous tributaries (particularly on the right side) join the valley by high steps. The KRIML ACHE descends by a 450 m high step. The same applies to other south-side tributaries such as STUBACHE, KAPRUNER ACHE, etc.

(b) Below BRUCK-FUSCH, the PINZGAU valley narrows. Near TAXENBACH (Km 151.0) it takes the form of a deep and narrow ravine with a steep gradient, continuing in the west-east direction. In this reach, the side valleys and tributaries, such as GASTEINER ACHE (Km 141.7), join the SALZACH through narrow gullies and waterfalls.

(c) At SCHWARZACH (Km 133.7), the ravine emerges again into a wide and flat-floored valley, turning in south-north direction. This valley is known as PONGAU TAL, and continues for approximately 30 km northward to WERFEN (TENNECK) at Km 110.9. In this reach the SALZACH is joined by:

1. GROSSARLER ACHE at Km 131.2
2. WAGRAINER ACHE at Km 127.7

(d) At TENNECK the valley breaks through NORTH LIMESTONE ALPS continuing for 13.5 km to GOLLING (Km 93.6) where it enters the Alpine foreland through the deep LUEG PASS.

(2) Geology.

(a) The drainage area of the SALZACH PINZGAU VALLEY is limited on the south by the high Alpine chain known as HOHE TAUERN. One of the longest and highest and a very distinct Alpine chain, it forms the backbone of the eastern part of the central Austrian Alps. It begins orographically on the BIRN GAP, but geologically has already started at BRENNER PASS. With its structure, it represents the continuation of the ZILLER ALPS. The GROSS VENEDIGER (3600 m.u.A.) and the GROSS GLOCKNER (3798 m.u.A.) are the highest peaks. Great petrographic varieties underlie the character of this mountain chain. The EISKOGEL-JOHANNIS-HOHE RIFFEL-KAPRUNER KAM are composed of Glimmer schist, phyllitic gneiss, and Limestone phyllit. However, archaic and crystalline schist (siliceaous in the deeper, and calcareous in its upper layers) form the geologic background of the TAUERN range. At KATSCHBERG, the HOHE TAUERN chain ends. Its continuation east are the lower RADSTADER ALPS, of basic mesozoic character.

(b) The northern delimitation of the SALZACH longitudinal valley is formed by the KITZBUHLER SCHIST ALPS, basically of grey wacke substance, which represent a failure zone depressed by nearly 1000 m against the HOHE TAUERN. The highest peak of the KITZBUHLER ALPS reaches 2300 m in the west falling to 1700 m.u.A. in the east. This range favors the formation of moraines and high slides. The DIENTENER MOUNTAINS and HOCHGRIND MOUNTAINS on the east side of ZELLER SEE still belong to the elevated schist zone.

(c) The glacial character of the UPPER SALZACH valley (PINZGAU and PONGAU) is evident everywhere. As a matter of fact, the valley follows the pre-glacial eroded furrow on the north foot of the Central Alpine chain of HOHE TAUERN. Numerous diluvial fans, terraces, as well as glacial gravel fields and deposits accumulated in the PINZGAU trough, testify to the past glacial activity. Geologically, the drainage area of the SALZACH is divided in three main geologic zones: Tauern crystalline zone, grey wacke zone, and limestone Alps.

c. LOWER SALZACH (Km 93.6 – 0.00).

(1) Topography. On the north side of the SALZACH break-through the NORTH LIMESTONE ALPS at LUEG, there begins a 2-3 km wide valley confined on both sides by high walls of the LIMESTONE ALPS. This valley spreads out into the 20 km long GOLLING-HALLEIN basin of the low and mildly sloped FLYSCH MOUNTAINS. A short distance northward is the SALZBURG basin, extending in all directions into long drawn-out depressions and secondary basins accommodating numerous lakes and moors, such as TRUMMER LAKE, WAGINER LAKE, WALLER LAKE, etc. The drainage boundaries of the SALZACH are here formed on the left side by the mountains of HOHER GOELL, (2522 m.u.A.) and UNTERSBERG, (1853 m.u.A.). On the right side, boundaries are defined by the HOHER ZINKEN chain (1762 m.u.A.) and the GAISBERG (1288 m.u.A.).

(2) Geology. Below SALZBURG, the SALZACH breaks through the glacial moraines at LAUFEN and again between RADEGUND and AUFHAUSEN, and then reaches the wide gravel fields of the SALZACH-INN plateau. (See Plate 4)

(3) Hydrology.

(a) In order to illustrate hydrologic conditions of the SALZACH, the following discharge data are given:

Station	Period	MQ (m^3/sec)
GOLLING	1931-35	135
SALZBURG	1931-35	163
SAALACH JUNCTION	1901-38	212
BURGHAUSEN-ACH	1931-37	251

(b) SALZACH flood waves become significant beginning at SALZBURG and exercise predominant influence on flood conditions of the INN River up to its junction with the DANUBE. (See paragraph A-04, Exhibit A, INN River Hydrology). In the SALZACH reach, WILDSHUT-OSTERMIETHING-TITTMONING-ETTENAU, considerable overbank flooding occurs. The flood wave crest is reduced and delayed by passing through this extensive overbank storage. At NW and MW the distance between SALZBURG and BRAUNAU, is traveled by the flow in 9-10 hours. At HW, 13-16 hours are needed for passage. Sharp flood waves, having less time for overflow, are faster. The velocities for various reaches of the SALZACH are:

SALZBURG-OBERNDORF	3.0 km/hr
OBERNDORF-OSTERMIETHING	8.2 km/hr
OSTERMIETHING-BRAUNAU	6.7 km/hr

B-03 EXISTING SALZACH RIVER DEVELOPMENTS.

a. STUBACHWERK Power Development. (Basis: References 6, 28, 42, 53-55)

(1) General. The STUBACH, tributary to the SALZACH River at Km 182.54, was developed for power production by the Austrian Government Railways in the period 1928-1950, in order to provide for electrification of the main line, SALZBURG-WOERGL. The exploitation of the STUBACH for power production is performed in three stages as follows:

STUBACHWERK I - EINZIGERBODEN
STUBACHWERK II - SCHNEIDERAU
STUBACHWERK III - UTTENDORF

(2) STUBACHWERK I - EINZIGERBODEN Power Development. (Serial No. R-23)

(a) STUBACHWERK I utilizes the flow of the STUBACH between its origin in TAUERMOSBODEN LAKE (elevation 2003 m.u.A.) and EINZIGERBODEN (elevation 1472.25 m.u.A.). (See Reference 53, Page 225; Reference 28, Page 336). The most important part of this development is the TAUERMOSBODEN LAKE storage reservoir created by raising its stage by means of a dam - TAUERMOSBODEN Dam.

(b) TAUERMOSBODEN Dam was constructed in the period 1928-1929. The construction was carried out under most adverse conditions, because of its location above 2000 m elevation close to the TAUERN GLACIER. The measurements of the dam which is of masonry gravity type are as follows:

Length of dam at crest	190.00 m
Maximum height above valley floor	28.00 m
Crest width	3.50 m
The width at the base	19.50 m
Crest elevation	2204.50 m.u.A.
KHW elevation (small floods)	203.80 m.u.A.
MW elevation	203.00 m.u.A.
Minimum storage elevation	1984.50 m.u.A.
Storage reservoir volume	21.5 hm^3 (increase to 65 hm^3 planned)

(c) The upstream side of the dam has 1:0.05 and the downstream side 1:0.7 slope. Both sides are reinforced by stone masonry. The main body of the dam is concrete masonry, partly reinforced. The spillway is 33.6 m long, and has 43 m^3/sec capacity. The bottom outlet of the dam is a steel pipe 2.0 m diameter, equipped with valve and shutter gate.

(d) The intake sill into the power conduit is elevation 1982.00 m.u.A. From there the flow is transferred by a 41 m long tunnel into the steel pipe penstock, placed in a tunnel drilled in heavy rock. The entrance to the penstock is developed in a Y form with 2 branches of 1.125 m inside diameter and a main branch of 1.80 m inside diameter. The two entry branches are regulated by automatic butterfly valves, operated from the platform 34 m above the reservoir sides. The valves are accessible through a shaft. The penstock entry has an elevation of 1982.0 m.u.A. The penstock is 1722 m long and descends towards the powerplant at EINZIGERBODEN in 4 different slopes, overcoming a total difference in elevation of 521 m. The inside diameter of the penstock varies from 1.80 m at the entrance to 1.20 m at its end (elevation 1472.0 m.u.A.), the entry to the turbine. The flow in the penstock is 8 m^3/sec at 7.1 m/sec velocity.

(e) The powerplant at EINZIGERBODEN (floor elevation 1472.3 m.u.A.) has 4 main turbines each 8000 HP power capacity and 1.52 m^3/sec flow capacity, combined with a generator for current production (See Reference 53, Page 250). The effective power capacity of the main turbines is 23,000 KW, the annual production amounts to 68 x 10^6, of which 25 x 10^6 KWH is the winter production. The utilized head is 525 m.

(f) The EINZIGERBODEN plant also utilizes the flow of the WEISSENBACH for production of power used locally. This stream originates in WEISS LAKE, elevation 2250.0 m.u.A., 15.7 hm³ capacity. (Serial No. R-24). The lake is impounded by 2 dams: NORTH DAM and EAST DAM. Summary of critical dimensions follows:

	NORTH DAM	EAST DAM
Crest length (m)	235	64
Crest width (m)	2.8	1.9
Width at the foot (m)	25.32	3.0
Height (m)	24.00	-

(3) STUBACHWERK II - SCHNEIDERAU Power Development.

(a) STUBACHWERK II was placed in operation in 1941. The tailwater of STUBACHWERK I is ponded in an equalizing pond having 1463.9 m.u.A. elevation and 250,000 m^3 storage capacity. The pond is located on STUBACH just downstream from the EINZIGERBODEN plant. The pond is equipped with a 52.3 m long spillway for floodwater discharge of 120 m^3/sec capacity.

(b) From the pond, a 1.5 km long power tunnel, with an intake at 1452.8 m elevation, 2.54 m inside diameter, and 0.017 - 0.05 percent gradient, directs the flow to a surge tank at elevation 1461.60 m.u.A. The surge tank consists of a vertical shaft of 3.60 m

diameter with an upper chamber 30.4 m long and a lower chamber 17.6 m long, both of circular cross section and 3.10 m diameter. From the surge tank, the 1309 m long penstock drops to the powerplant (elevation 1042.0 m.u.A.) located at the junction of SCHRUBACH and STUBACH, near SCHNEIDERAU. The gross head of the development is 420 m.

(c) The equipment of the powerplant consists of 2 machine units each 16,000 HP and 3.75 m^3/sec flow capacity with maximum effective power of 25,000 KW. The annual production is 85 x 10^6 KWH, of which 25 x 10^6 is generated in the winter period. An extension for a third turbine unit is planned. The flow of the SCHRUBACH is also diverted towards the powerhouse and utilized for power generation.

(4) STUBACHWERK III - UTTENDORF POWER DEVELOPMENT.

(a) This project has been in operation since 1950. A short distance downstream from SCHNEIDERAU powerplant, a pondage basin impounds the tailflow of STUBACHWERK II as well as the remaining flow of the STUBACH itself. The elevation of this pondage reservoir is 1003.5 m.u.A. The pond has a movable weir with 3 openings and 1 bottom outlet sluice of the following dimensions:

Double sluice gates: 4.28 x 1.65 m lower leaf
4.28 x 2.10 m upper leaf for weir openings

Double sluice gates: 2.10 x 1.80 m lower leaf for scour sluice opening
2.11 x 2.40 m upper leaf

(b) A free surface tunnel, 7300 m long, 0.01 percent gradient, carries the flow to a surge tank at elevation 1027 m.u.A. From there, a 4.00 - 3.60 m diameter penstock carries power flow to 3 turbines in the UTTENDORF powerplant (elevation 797.0 m.u.A.). The utilized flow in the UTTENDORF plant is 3 x 4.85 m^3/sec. The tailrace is at 791.0 m.u.A. elevation. Effective power capacity of the plant is 27,000 KW; annual production is 75 x 10^6 KWH; utilized head is 230 m. The tailrace (cross section 4.40 x 4.50 m, 500 m long) empties into the STUBACH.

b. KAPRUNER ACHE Power Development. (Basis: References 24, 32, 57, 58, 60, 61)

(1) General.

(a) The KAPRUNER ACHE power development is the largest hydroelectric enterprise now existing in AUSTRIA. It is one of the six groups designed for comprehensive power exploitation of the unusually suitable Alpine region known as HOHE TAUERN. This region covers approximately 1600 km^2 in the high-located central massif of the AUSTRIAN ALPS. The region averages 2100 m elevation. It extends between the SALZACH and DRAU Rivers at the south, between DEFEREGGENGEBIRGE and KRIMMERTAL in the west, and HAFFNER GROUP in the east. The highest

peaks in these mountains are GROSSGLOCKNER, 3798 m.u.A. and GROSS VENEDIGER, 3360 m.u.A. (See Fig. 1, Reference 32, Page 325).

(b) Only 2 of these 6 groups are located in the SALZACH drainage area on the north slope of HOHE TAUERN, namely: KAPRUNER ACHE, with 124 km^2 drainage area, and the proposed FELBERSBACH-HOLLERSBACH Development with 174 km^2 drainage area. STUBACHWERK I, II, III, described in paragraph A-03a are also in the drainage area of the SALZACH River on the north slope of HOHE TAUERN. All other groups are located in the drainage area of the DRAU River on the south slope of the TAUERN. (e.g. the MATREI and HUBEN developments of the DRAU Basin)

(c) KAPRUNER ACHE originates beneath the PASTERZEN GLACIER and joins the SALZACH on the right side at Km 182.54 near KAPRUN. Its course through a deep and steep Alpine valley is characterized by 2 outstanding horizontal floor areas. One floor at approximate elevation 1600 m.u.A. is called WASSERFALLBODEN. The second is MOSERBODEN at an approximate elevation of 2000 m.u.A. Both are unusually suited for development of storage reservoirs. These are being developed by means of 3 dams:

1. LIMBERG Dam (WASSERFALLBODEN Reservoir)
2. HOEHENBURG Dam-West (MOOSERBODEN Reservoir)
3. HOEHENBURG Dam-East (MOOSERBODEN Reservoir)

(d) The LIMBERG Dam was built in the period 1947-1951 and has been in operation since then. It serves as an annual storage reservoir for the lower part of the KAPRUNER ACHE Development. The other 2 dams, HOEHENBURG-West and East, have been under construction since 1950, with prospect for completion in 1956. They serve the upper part of KAPRUNER ACHE Development.

(2) LIMBERG Dam. (Serial No. R-27)

(a) The LIMBERG Dam is located at the north end of the WASSERFALLBODEN in a deep and narrow ravine. (See dam sketch on Plate 9b) It is a concrete masonry arch with the following dimensions:

Crest elevation	1672 m.u.A.
Maximum stage elevation	1670 m.u.A.
Minimum stage elevation	1590 m.u.A.
Stilling basin elevation	1565 m.u.A.
Volume of reservoir	83.6 hm^3
Surface area of lake	153 ha
Total height of dam	120 m
Length of crest	370 m
Width of crest	5 m

(b) The total annual average inflow of the LIMBERG (WASSERFALLBODEN) reservoir is 245.8 hm^3 of which 215.2 hm^3 enters in summer, 30.6 hm^3 in winter months. A spillway provides for passing of floodwater. On the left side of the valley, close to dam, is the entrance into the pressure tunnel. This tunnel is 7060 m long, 3.20 m inside diameter, drilled through rock and vaulted inside with concrete and lined to prevent seepage. Its flow capacity is 32 m^3/sec. It empties in a surge tank located at MAISKOGEL (1508.00 m.u.A.) in the SALZACH valley above KAPRUN. The 1700 m long pressure tunnel is interrupted in 2 places by intake structures, in order to receive the impounded flow of 2 streams; ZEFERETBACH, 4.4 km^2 drainage area, and GRUBACH, 4.5 km^2 area.

(c) From the surge tank, a 576 m long and 3.0 m diameter inclined tunnel leads to the regulating mechanism, located in the valve chamber. From there, a distributor divides the flow into 4 steel penstock pipes each 1200 m long, 1.3 m inside diameter, and 1.15 m^2 cross section area. The penstocks descend into the main powerplant in KAPRUN. The gross head of this part of KAPRUNER ACHE Development is 889 m, which represents the difference between 1670 m at LIMBERG reservoir and 781 m elevation at the jet outlet into the turbine at KAPRUN.

(d) The powerplant at KAPRUN in its ultimate development provides for 4 turbine units, 2 x 45,000 KW and 2 x 55,000 KW, totaling 200,000 KW power capacity. Annual production amounts to 210 x 10^6 KWH.

(3) <u>MOOSERBODEN Reservoir. (Serial Nos. R-25, R-26, R-28)</u>

(a) The second stage of KAPRUNER ACHE power development, under construction since 1950 with accomplishment planned for 1955, utilizes the upper part of this stream by means of MOOSERBODEN reservoir. The first step to this development was the tapping of the sources of the MOELL River, a tributary of the DRAU River. This part of the development was constructed in order to utilize the outflow of the GLOCKENER PASTEURZ GLACIER and of the LEITERBACH (a tributary of the MOELL) for the purpose of KAPRUN power development on the north side of the HOHE TAUERN. This tunnel was completed and placed in operation in 1952. The main part of this development is the damming of PASTERZ glacier flow and MOELL River flow by 2 dams (north and south) to create an artificial reservoir called MARGARITZE.

(b) <u>MARGARITZE Reservoir. (Serial No. R-28)</u> has 3 hm^3 storage capacity at maximum pool of 2000.00 m.u.A. At 1990 m.u.A., the storage is 1.2 hm^3. The north dam "MOELLSPERRE" is an arch gravity type, 77.0 m high, 110.0 m long at the crest. The south dam "MARGARITZENSPERRE" is 38.0 m high, gravity type, 95.0 m long. The bottom outlet on the north dam, into the MOELL, is 150.0 m long and 2.20 m diameter.

(c) The LEITERBACH is redirected into the MARGARITZE Reservoir by a 1.8 km long conduit of 2.2 m diameter and 3 m^2/sec capacity. The MOELL conduit to KAPRUN has 2.60 m clear diameter, 0.35 - 0.40 percent maximum gradient, 17.0 m^3/sec flow capacity. (See Reference 6, OESTERREICHISCHER KATASTER MOELL III 7a, also Reference 57, Page 334 and Reference 24) The transfer conduit is 11,655 m long and is drilled through the massif of the GROSSGLOCKENER. An intake structure provides for transfer of the KAEFERTAL flow, (9.6 km^2 drainage area) into the conduit. It empties its flow into the MOOSERBODEN RESERVOIR. Because of difference in elevation between MARGARITZE LAKE, (elevation 1990-2000 m.u.A.) and MOOSERBODEN Reservoir (2025-2035 m.u.A.) a pumping station at the northern end provides for the lift from the MOELL to the SALZACH drainage area.

(d) <u>HOEHENBURG Dams, West and East. (Serial Nos. R-25 & R-26)</u> The MOOSERBODEN Reservoir is formed by means of 2 dams of gravity type. The East Dam is proportionally smaller than the West Dam. HOEHENBURG West Dam has the following divisions:

Crest elevation	2037 m.u.A.
Reservoir storage	86 hm^3
Maximum stage elevation	2035 m.u.A.
Minimum stage elevation	1953 m.u.A.
Height above the floor	100 m
Crest length	500 m

(e) The water storage impounded in the MOOSERBODEN Reservoir is transferred into a 4366 m long pressure tunnel of 3.20 m clear diameter leading to the surge tank located above the LIMBERG Dam. The flow from the surge tank is transferred through a 520 m long pressure shaft of 2.6 m diameter to the powerhouse. The powerhouse is located partly inside the foot of the LIMBERG Dam. The total utilized gross head at LIMBERG powerplant is 360 m, maximum flow 36 m^3/sec. The tailwater of the LIMBERG powerplant is transferred back into the WASSERFALLBODEN Reservoir, by a pumping installation consisting of 2 pumps each 76.4 m^3/sec capacity. The power capacity of LIMBERG powerplant is 100,000 KW.

c. <u>BAERENWERK Power Development.</u> This hydroelectric power development exploits the flow of the FUSCHER ACHE, a right side tributary of the SALZACH at Km 160.3. A bear-trap weir impounds the water of the FUSCHER ACHE near FERLEITEN. A 3.5 km long free-flow tunnel impounding the flow of several small tributaries of the FUSCHER ACHE leads to a surge tank, from which two 923 m long pressure pipelines lead to the powerplant near FUSCH. The power units consist of 2 Pelton turbines directly coupled to two 1550 KW alternators and one Pelton turbine directly coupled to a 4900 KW alternator. The total capacity is 8000 KW.

d. TAXENBACH (RAURIS) Power Development. This development uses the lowest stage of the RAURIS ACHE, a tributary of the SALZACH with junction at Km 149.00. The utilized head is 125 m. A free flow tunnel 315 m long, leads to a 525 m long penstock. The power unit consists of 4 turbines of 6000 KW power capacity. Annual production is 35×10^6 KWH.

e. GASTEINER ACHE Power Development.

(1) The GASTEINER ACHE, a right side tributary of the SALZACH at Km 145.685 is developed for power production in 2 stages: LEND I and LEND II.

(2) LEND I. (Serial No. R-29) uses the lowest stage of the GASTEINER ACHE with 95 m head. The stream is dammed and an 800 m long tunnel leads to a 240 m penstock, the last 90 m of which are in a shaft. The power capacity of LEND I powerplant is 15,000 KW. Annual production 30×10^6 KWH.

(3) LEND II uses the upper stage of GASTEINER ACHE above LEND I. The utilized head is 173 m and power capacity is 7000 KW.

f. GROSS ARL BACH Power Development.

(1) The GROSS ARL BACH is a right side tributary of the SALZACH at Km 131.2. Its flow is exploited in 2 stages: GROSS ARL I and GROSS ARL II.

(2) GROSS ARL I (PLANKENAU) is a high head station (100 m head) utilizing the second lowest stage of the GROSS ARL BACH. The powerplant is equipped with 3 Francis turbines of 3200 KW power capacity.

(3) GROSS ARL II uses the lowest stage of GROSS ARL BACH. Its head is 165 m. Three Francis turbines have 8400 KW power capacity. Annual production is 43.5×10^6 KWH.

g. ARTHURWERK and MUEHL BACH Power Development. The MUEHL BACH is a left side tributary of the SALZACH at Km 121.2. This power development uses the water of the MUEHL BACH. The flow is led through a 5 km long conduit to the neighboring SALZACH valley from where a pressure pipeline leads to the power station in the valley below. The head is 196 m. Power units consists of 3 Pelton units of 2760 KW capacity.

h. ALM BACH Power Development. (Serial Nos. R-31 and R-32)

(1) The ALM BACH, a right tributary of SALZACH, joins it at HALLEIN, Km 81. It is exploited for power development in 2 stages:

WIESTAL and STRUBKLAMM

(2) WIESTAL Powerplant (Serial No. R-32) constructed in the period 1910-1912, is located 14 km southeast of SALZBURG. A gravity dam, (35 m high and 69 m long at its crest) built across the south end of the WIESTAL forms a storage reservoir of the following dimensions:

Maximum stage elevation	555.00	m.u.A.
Minimum stage elevation	544.00	m.u.A.
Storage capacity	7.5	hm^3
Surface area	103	ha

A 1.23 km long tunnel leads to a surge tank from which 2 penstocks of 322 m length lead to the powerhouse on the left bank of the ALM BACH. The power units consist of 3 spiral Francis turbines, two of 1000 KW each and one of 1700 KW, total capacity 6400 KW. Annual production capacity 35×10^6 KWH.

(3) STRUBKLAMM Powerplant (Serial No. (R-31) located 16 km ESE of SALZBURG, was developed in 1932. It is a high head installation utilizing the flow of the STRUB BACH above WIESTAL. The utilized hydraulic head is 105 m. The STRUB BACH is impounded by the 36.5 m high and 86 m long STRUBKLAMM Dam equipped with a bear-trap weir forming a storage reservoir of the following dimensions:

Maximum stage elevation	668.00	m.u.A.
Minimum stage elevation	658.00	m.u.A.
Storage capacity	2.5	hm^3
Surface area	38	ha

(4) A tunnel conveys water from the HINTERSEE to the STRUB BACH reservoir. The HINTERSEE dimensions are:

Maximum stage elevation	683.00	m.u.A.
Minimum stage elevation	669.00	m.u.A.
Storage capacity	7.5	hm^3
Surface area	95	ha

(5) From the intake at the STRUBKLAMM Reservoir, a 2.45 km pipeline leads to a surge tank. From there a 135 m inclined penstock leads to a powerhouse located on the WIESTAL STAUSEE. The power units consist of 2 Francis turbine sets each 1700 KW and one set of 4400 KW. Total capacity is 7800 KW and annual production 24×10^6 KWH.

B-04 SALZACH RIVER DEVELOPMENTS IN PLANNING STAGE.

a. FELBERSBACH-HOLLERSBACH Power Development.

(1) This development covers a 174 km^2 drainage area of the HOHE TAUERN and is planned around the FELBERSBACH-HOLLERSBACH, both tributaries of the SALZACH, as its main hydroelectric supply. The 6 powerplants which are at present in preliminary stages of development are as follows:

WEISSENECK	11,000 KW
FREIWAND	6,000 KW
HOLLERSBACH	12,000 KW
HINTERSEE	78,000 KW
WASSERFALL ALN	62,000 KW
MITTERILL	55,000 KW

(2) The storage reservoirs to be built and which are designed for 332 hm^3 capacity are as follows:

KRATZENBERGSEE
MITTERSEE
PLATSEE
WEISSENECK ALN
WASSERFALL ALN

B-05 SAALACH RIVER DEVELOPMENTS.
(Basis: References 67, 68, 69)

a. General. The SAALACH River, 115 km long, is the major tributary of the SALZACH, joining the latter on the left side at Km 59.3 near VOCKENBERG. From this junction to Km 11.8 near GOIS, the SAALACH forms an international boundary between AUSTRIA (Province of SALZBURG) and GERMANY (Province of BAVARIA). From GOIS upstream to its sources, the SAALACH is confined to German territory. SAALACH is an Alpine river with abundant water supply. Following are the hydrologic data for the stream taken at the JETTENBERG gaging station:

MQ Average 1901-1936	38.8 m^3/sec
MQ (highest) (1910)	52.7 m^3/sec
MQ (lowest) (1928)	29.5 m^3/sec
MNQ	9.6 m^3/sec
NQ (1911)	6.0 m^3/sec
MHQ	334.0 m^3/sec
HQ (1920)	716.0 m^3/sec
HHQ	800.0 m^3/sec

b. SAALACH-ROTT (FREILASSING) Power Development. (Serial No. R-34)

(1) This power development was started in 1942 by the Germans and is at present being completed by the government of Austria. It is located at Km 2.5 near ROTT on the Austrian side and near FREILASSING on the Bavarian side. The installation is of new design called "submersible" powerplant. (See Figs. 7, 11, 15, Reference 68) The power-generating equipment consisting of 3 turbine units is placed inside the fixed weir. A movable crest gate is mounted on top of the fixed weir structure. The turbine intakes, equipped with control gates, trash rack and emergency closure, divert the flow to turbines with shafts inclined in the direction of the axis of the intake conduits. The crest of the structure extending across the entire width of the river serves as a gated spillway during the flood period. The elevation of the fixed crest is 414.55 m above sea level, and of the top of the movable crest gate is 415.80.

(2) Flood discharge is further facilitated by 4 discharge conduits through the base of the dam, located on each side of the conduits serving the turbines. These discharge sluices, equipped with segment gates, also serve to improve the power output of the plant. When open during the time of flood flow, the jet action below the dam depresses the tailwater and, therefore, has the effect of recovering in part the head that otherwise would be lost due to high tailwater.

(3) An operating gallery within the dam extending across the entire river channel provides access for servicing of the installation, including the collapsible crest shutter hinged to the crest of the weir. In the closed stage, the shutter dams the flow to elevation 415.80 m.u.A. which is the elevation of the upper pool. The total hydraulic head utilized by the installation is 8.23 m. The mean water (MW) flow utilized in this powerplant amounts to 60 m^3/sec, the HHW flow to 1000 m^3/sec. The installed power capacity of the 3 turbine units amounts to 5600 KW.

c. SAALACHWERK-REICHENHALL Development. (Serial No. R-33)

(1) This development is located on German territory in the province of BAVARIA. It was constructed during the period 1927-30. The SAALACH is dammed at Km 20.69 near KIBLING by a 77 m long dam with a pool elevation of 486.30 m.u.A. Backwater above the dam extends approximately 2.6 km to 23.34. The pool is 240-470 m wide and 320 m in the middle. The maximum depth of the pool above the average level of the river bed is 6.8 m. The total volume of the pool is 3.456 hm^3. For power generation, there may be utilized 2.5 m which provides 1.847 hm^3 usable storage.

B-05c

(2) The dam is equipped with 2 flow regulating gates. One is a 10 m wide floodwater gate with sill elevation 483.5 m.u.A. The second gate is a 13.6 m wide bottom outlet with sill elevation 477.5 m.u.A. The HHW flow is 800 m^3/sec.

(3) The power flow from the pool is conducted by a pressure tunnel of 16 m^2 cross-sectional area into a powerplant located at KIRCHBERG. The intake sill of the pressure tunnel is at elevation 479.8 m.u.A., which is 6.2 m under the normal pool stage. When the stage elevation is lowered 2.5 m, the flow amounts to 40 m^3/sec. At the normal stage, there exists an average 19.5 m head. The installed power capacity is 6600 KW and the average annual power capacity is 4780 KW.

EXHIBIT C

HYDRAULIC DEVELOPMENTS IN THE TRAUN RIVER BASIN

EXHIBIT C

HYDRAULIC DEVELOPMENTS IN THE TRAUN RIVER BASIN

C-01 INTRODUCTION.

This exhibit consists of abstracts of technical literature concerning the physical and hydraulic characteristics and the hydraulic developments of the TRAUN River Basin of the AUSTRIAN ALPS. Reference is made to paragraph A-01 of Exhibit A for discussion of the source material and other reference data.

C-02 TOPOGRAPHY. (Basis: References 6, 7, 12)

a. The drainage area of the TRAUN River covers parts of the Alpine Foreland, the Flysch Zone and the North Limestone Alps. The area is characterized by numerous lakes in which the TRAUN River originates or through which it passes on its course towards the DANUBE. Several lakes are also located on its tributaries. Among the lakes, the most outstanding along the main stem of the TRAUN are: TOEPLITZ, GRUNDL, ALTAUSSEER, HALLSTAETTER, and GMUNDEN SEEN (Lakes). On the AGER tributary are located: ZELLERSEE, MONDSEE and A RSEE. On the ISCHL River are FUSCHLSEE and WOLFGANGSEE. On the GOSAUBACH are the 3 GOSAU Lakes. The ALMSEE is located on the right side ALM-KREMS tributary. The lakes are shown on the river basin map, Plate 2c.

b. The TRAUN is a north Alpine river. Its sources, and the major part of its drainage area, are located in the North Limestone Alps. Part also lies in Alpine Foreland. The Alpine part, known as SALZKAMMERGUT, lies in the Limestone High Alps of the DACHSTEIN Range (whose highest peak is 2296 m.u.A.) and the Totes Gebirge Mountains. The Limestone Foreland portion includes the HOELLEN GEBIRGE and TRAUNESTEIN Ranges. The Flysch Zone, which serves as a transition into the Alpine Foreland, is bounded on the east by the flats of the TRAUN-ENNS Plateau, in the west by the left side watershed of the HAUSRUCK Mountains.

c. The TRAUN River is formed by the confluence of 3 streams known as the KAINISCH, GRUNDLSEE and ALTAUSEE TRAUN, which originate in lakes and join in the AUSEE Basin. The plateau of that basin, 700-800 m.u.A., extending into numerous dead-end valleys, is enclosed by high mountain ranges, into which the river beds lie in 80-100 m deep gorges.

d. The TRAUN forces its flow through the KOPPENTAL Valley between the SARSTEIN and DACHSTEIN Plateau towards the HALLSTAETTER SEE, In its upper part, this lake is clogged by sediments. The GOSAUBACH, a left side tributary of the lake, penetrates deeply into the DACHSTEIN group, forming the 3 GOSAU Lakes and flowing through very steep narrow gorges in its lower reach.

C-03 GEOLOGY. (Basis: References 6, 7, 12)

a. Below STEEG, the TRAUN flows through the GOISERN Basin. This consists of Jurassic and Triassic layers, representing the farthest extent of the former TRAUN Glacier. High terrace type moraines are found on both sides south of GOISERN. Following the narrow valley of LAUFEN, the TRAUN valley widens into the ISCHL Basin, where it is joined by the ISCHL River, the outflow of WOLFGANG SEE.

b. The TRAUN Valley follows then the dolomitic syncline between the limestone masses of the TOTES GEBIRGE and HOELLEN GEBIRGE. The widening of the valley at the junction with the WEISSENBACH also represents the area of the former TRAUN Glacier. The glacier joined here with GMUNDEN LAKE which, at that period, reached 470-480 m.u.A. elevation. Since then, the lake has sunk to 422 m.u.A. and its surface area has considerably shrunk. Several huge moraines surround the northern end of the lake. The highest of these is at PENCK.

c. Diluvial, fluvial glacial gravel fields and valleys filled with moraine fans extend north of TRAUN SEE. As far as LAMBACH, the TRAUN is cut into diluvial conglomerate terraces in a deep and narrow canyon. Below LAMBACH, the valley floor widens. The right bank is formed by a 70-80 m high and steep abrupt slope of an extensive diluvial gravel terrace complex on top of SCHLIEREN base knownas TRAUN-ENNS Plateau. On the left bank, the WEISER HEIDE which extends to the DANUBE, and the SCHLIEREN GEBIRGE both are of Tertiary origin with Miocene schlieric marl and Pliocene gravel.

d. The geologic survey of the TRAUN drainage area shows that Triassic formations cover the major part in the Alpine region. Jurassic limestone marl and siliceous schist are concentrated in the ISCHL Basin. The Chalk period formations (upper Chalk, Flysch, and lower Chalk) predominate in the Flysch Zone. The Alpine Foreland of the lower TRAUN is predominantly of Tertiary origin.

C-04 HYDROLOGY. (Basis: References 6, 7, 12)

a. The hydrology of Traun drainage area is largely influenced by the Karst type character of the North Limestone Alps. In addition to surface runoff, water in this region also follows a subterranean course. Water enters underground through surface cracks. The runoff is thus delayed and other hydrologic irregularities are created. On account of the fast moving surface runoff and resulting lack of evaporation and also on account of the restricted cultivated area, the runoff coefficient is high, reaching 80 percent of precipitation for the Limestone Alpine part of the drainage area.

b. **In the case of the GOSSAUBACH**, the subterranean character of the flow is evident. The GOSSAU SEE has a 90 hm^3 annual inflow, the outflow is 3.9 hm^3, which is only 6 percent of the inflow. The rest of the flow reaches the TRAUN River by subterranean passages. Similar conditions exist on GRUNDL SEE where the ratio between inflow and outflow is 60 percent (16.6 hm^3 against 27.6 hm^3). In ALTAUSEER SEE the ratio is 80 percent (10.1 against 12.8).

c. Following intense precipitation or sudden snow melting, the floodwater effects are always first evident in the region of VOECKLA. The floodwave formed there moves downstream and creates flood conditions on the AGER River. It usually reaches the TRAUN River together with the floodwave of the ALM and creates the high water conditions up to junction with the DANUBE. In rare cases, when the region of KREMS River has high precipitation, only the lower reach of the TRAUN has high stages (approximately corresponding to a 10 year flood).

d. The floodwave of the AGER proceeds into the TRAUN (from VOECKLABRUCK in approximately 12 hours. The TRAUN SEE reaches its highest stage the next day and delays rapid fall of stages in the TRAUN below STADL. If the precipitation in the TRAUN Valley above GMUNDEN is very high, a second rise of stage may occur below STADL. Above EBENSEE, high stages are the result of the small tributaries and not of the main stem floodwave because the numerous lakes moderate the discharge rate. This retaining capacity of the lakes during the floodwater period is considerable.

e. The flood plain of the TRAUN River, between LAMBACH and the junction with the DANUBE was inundated during the 1897 and 1899 floods, when the discharge at WELS reached 1750-1900 m^3/sec. Since then, the bed of the TRAUN River below the WELSER Weir as far as MARCHTRENK was considerably deepened. The effect of this depth increase made overtopping of banks by floodwater no longer possible. The high dikes on both sides in the lower reaches also help to prevent overbank flooding. The constriction of the valley created by the dikes has not appreciably increased flood stages. At EBELSBERG, flood stages have been increased 0.2-0.6 m due to con- of the dikes.

C-05 HYDRAULIC STRUCTURES. (Basis: References 6, 7, 12)

a. General.

(1) The TRAUN River is regulated and controlled over its entire course by means of a system of extensive hydraulic structures, developed progressively in the period going back to the Middle Ages, when salt mines of SALZKAMMERGUT, (the AUSSEE and GRUNDLSEE regions) supplied the major part of central Europe with salt. This salt was transported on barges down the TRAUN and DANUBE Rivers. Also, an extensive lumber industry in the TRAUN area depended mostly on floating of timber rafts down the river.

(2) These developments include bank and bed revetments, dikes, groins, mills, lake outlet controlling structures (known as "Seeklause"), numerous dams, weirs and locks regulating the flow for navigation of small craft, raft floating and power utilization. Recently, the whole hydraulic system of the TRAUN River has been revised and new structures developed to provide for coordinated hydro-electric power production.

(3). The lake outlets controlling structure (Seeklause) of TOEPLITZ, GRUNDL, and ALTAUSEE are very old and primitive types, and operable only at medium stages. They have to be opened as soon as the stage rises to mean high water (MHW). They cannot be operated at high water (HW) conditions. The most recent of these structures is the WOLFGANGSEEKLAUSE in STROBL, which was reconstructed in 1913. This weir can be operated at flood conditions. The majority of the flow regulating dams and navigation locks, with few exceptions, consist of very old timber structures or stone and timber cribs.

b. TOEPLITZ SEEKLAUSE (R-35), controlling the outflow of TOEPLITZ SEE, Km 153.30, MW stage 718.05 m.u.A., HW 720.10 m.u.A. The area of the lake is 0.54 km^2, the total stored volume 34 hm^3, the maximum depth 106 m, mean depth 62.4 m. The retaining capacity of the lake during flood water is 1.3 hm^3.

c. GRUNDL SEEKLAUSE (R-36), a very ancient structure, regulates the outflow of the GRUNDL SEE into the GRUNDL-TRAUN. The drainage area above the structure is 125 km^2, the surface area of the lake 4.14 km^2, the total storage volume 137.5 hm^3, maximum depth 63.8 m, mean depth 33.2 m. The retaining capacity of the lake during flood-water is 10.7 hm^3. Stages and corresponding discharges are:

Stage (m.u.A.)		Discharge (m^3/sec)		Year
NNW	707.53	NNQ	1.10	1920
MNW	707.65		—	—
MW	708.06	MQ	5.26	1940-44
MHW	708.99		—	—
HHW	710.15	HHQ	97.0	1897

d. ALTAUSSEE KLAUSE (R-37), located 4.6 km above the junction of GRUNDLSEE and AUSSEE-TRAUN. It regulates the outflow of ALTAUSSEER SEE. The drainage area is 54.5 km^2, the area of the lake 2.09 km^2, total storage volume is 72.4 hm^3, maximum depth is 49 m, and mean depth is 34.6 m. The retaining capacity of the lake during floods is 6.1 hm^3. The stages and discharges of the lake are:

Stage (m.u.A.)		Discharge (m^3/sec)		Year
NNW	711.39	NNQ	0.42	1931
MNW	711.54	—	—	—
MW	711.91	MQ	3.20	—
MHW	713.42	—	—	—
HHW	714.20	HHQ	75.00	1897

e. WOLFGANGSEEKLAUSE (R-41), in STROBL, located on the ISCHL River outlet of WOLFGANG SEE. The ISCHL joins the TRAUN River at Km 103. This structure was reconstructed in 1913 and its present condition enables operation during HW conditions. The drainage area is 122.5 km^2. The area of the lake is 13.2 km^2, the total volume 619.2 hm^3, maximum depth 109 m, mean depth 47.1 m. The retaining capacity of the lake during floods is 44.6 hm^3. The stages and discharges are:

Stage (m.u.A.)		Discharge (m^3/sec)		Year
NNW	537.61	NNQ	1.6	1911
MNW	537.80	—	—	—
MW	538.20	—	—	—
MHW	538.89	—	—	—
HHW	539.90	HHQ	266	1920

f. SEEKLAUSE STEEG (R-39), km 118.04-117.81 controls the outflow of HALLSTAETTER SEE together with STEEGPOLSTER Dam. The drainage area is 641.8 km^2. The HALLSTAETTER Lake has 6.58 km^2 surface area, total storage volume of 556.7 hm^3, 125.2 m maximum and 64.9 m mean depth. It retains 15.7 hm^3 during the passage of floodwater. The stages and discharges are:

Stage (m.u.A.)		Discharge (m^3/sec)		Year
NNW	507.64	NNQ	7.20	1925
MNW	507.73	—	—	—
MW	508.35	MQ	34.80	—
MHW	509.30	—	—	—
HHW	510.66	HHQ	427.00	1920

The SEEKLAUSE structure is 102 m long and has 11 gates, 2.9-4.2 m wide and 1.2-1.45 m high. Downstream from the structure is located the STEEGPOLSTER, which is a fixed overflow dam 112 m long and equipped with 83 movable stoplogs. Between HALLSTAETTER SEE and TRAUN SEE (GMUNDEN), there are 4 flow regulating dams (See Table C-I following the text of this exhibit). These dams are:

GOERB and GRANITZ POLSTER (Dam)	Km 115.23-115.04
EISEL POLSTER (Dam)	Km 114.64-114.00
GOISERER TRAUNWEHR (Dam)	Km 113.69-111.50
ANZENAU POLSTER (Dam)	Km 110.52-109.62

These are all very old and primitive stone and timber crib structures providing for diversion of TRAUN flow to small mills.

g. TRAUNSEEKLAUSE (R-43).

(1) This dam regulates the outflow of TRAUNSEE (Lake), km 73.08-72.87. The drainage area is 1418 km^2. The lake has 25.7 km^2 surface area, 2302 hm^3 total storage capacity, 191 m maximum and 89 m mean depth. At flood conditions the lake retains 90.8 hm^3. The stages and discharges are:

Stage (m.u.A.)		Discharge (m^3/sec)		Year
NNW	421.89	NNQ	9.5	1929
MNW	421.94	-	-	--
MW	422.44	MQ	76.98	—
MHW	423.49	-	-	—
HHW	425.44	HHQ	1100	1920

(2) The TRAUNSEEKLAUSE is developed as a combination of 2 dams in angular positions across the stream. At the upper end is a lock 8 m wide for upstream navigation. On the left side of this lock is the KOSSELMUHLWEHR Dam. On the right side of the dam are located 2 other navigation locks of which one is 8.75 m wide, the other 8.7 m wide.

(3) The KOSSELMUHLWEHR Dam has 2 floodwater outlets, and also 10 shutters, of 15 m total width. In the right part of the dam are 12 shutters, 16.6 m total width, above the 2nd lock, and 14 shutters of 17.5 m total width in the KURZMUHL part of the dam. The weir is topped by a movable 0.18 m high timber cap.

(4) The total length of the dam is 357 m of which 167 m comprises the left part and 190 m the right part. On the right side of the dam, the millrace supplies 2 turbine units of the KURZ MUEHLE (Mill). On the left side is located the intake into the KOSSELMUEHLE millrace operating 2 waterwheels.

(5) Downstream from TRAUNSEE KLAUSE, between Km 73.08 and Km 66.59, are located the following 4 dams:

GOGLMUEHL and VOGLSANGWEHR	Km 72.49-72.33
THERESIENTHALERWEHR	Km 71.13-70.79
HAMSTOCKWEHR	Km 69.36-69.00

The last two structures are being eliminated by the reconstruction of the RADLMUEHLWEHR. The upper pool of this new development will submerge the THERESIENTHALERWEHR and HAMSTOCKWEHR.

h. RADLMUEHLWEHR, Km 67.36, has been under construction since 1948. It will replace the old MARIENTHALERWEHR Dam, KAINZMUEHLWEHR, and also eliminate the 2 dams mentioned above. The new structure provides for an upper pool elevation of 413.25 m.u.A., and a tailwater elevation of 407.25 m.u.A. The new dam is to be a 50 m long concrete structure, and is to have 2 openings with sluice gates 10 m wide, 4.0 m deep. The bottom outlet will be 3 m wide and 5.5 deep. The development will serve 3 turbine units, two at 26.5 m^3/sec, one at 22.5 m^3/sec, total 75 m^3/sec capacity.

i. TANZERMUEHLWEHR, Km 64.94, has been in the process of reconstruction since 1949 to replace the old primitive fixed overflow dam. Because of the new upper pool elevation, which in ultimate condition will be elevation 407.24 m.u.A., the other 2 dams (REINTHALERWEHR, Km 66.44 and BRUCKMUEHLWEHR, Km 65.65), will be eliminated. The new structure is being developed as a "run-of-the-river" weir consisting of 27.5 m long concrete fixed part of 406.24 m.u.A., crest elevation, topped by a 1 m high reclining hinged shutter. On the left side of the fixed part, are two 3.7 m wide sluices with sill elevation of 403.96 m.u.A. Two floodwater openings each 5.2 m wide, sill elevation 403.96 m.u.A., will be provided. In addition there will be 2 bottom outlets each 2.5 m wide. On the right side of the fixed part of the weir are 4 turbine intakes, 52-60 m^3/sec total capacity. Between TANZERMUEHLWEHR and Km 36.20, there are 7 fixed overflow dams of old fashioned stone and timber construction. Data appear in Table C-I. These dams are as follows:

Dam	River Km
KOHLWEHR	64.45-63.55
STEYERMUEHLWEHR	63.27-62.29
GESCHROEFFWEHR	61.96-61.83
SIEBENBRUNNERWEHR	59.73-59.70
TRAUENFALLWEHR	59.50
KEMATINGERWEHR	54.43-54.17
LAMBACHER SPINNEREIWERKE	48.90

j. WELSER WEHR (Weir), Km 36.20, is a concrete structure of 324.54 m.u.A. crest elevation with a three-section reclining shutter 1.46 m high, 29.5 long, permitting raising pool stage to 326.00 m.u.A. The shutter operates between 2 midstream pillars and 2 side walls. The intake structure into WELSER MUEHLBACH is equipped with a three-section sluice gate. On the right side of the weir is a 2.0 m wide fish ladder with a swing gate. A 9 m wide floodwater sluice with overflow sill at elevation 321.00 m.u.A., a gate, and also a 5.00 m wide gated sluice. The intake to the right side feed-water canal is 13.30 wide, equipped with 5 sluice gates leading to the WELSER powerplant. The canal is 2050 m long, 48.5 m^3/sec capacity. The tailrace empties into the TRAUN at Km 33.95.

k. The MUEHLBACH flows on the left bank of the TRAUN, parallel to the latter and located outside of the flood area. The weirs on this canal supply power to 32 industrial enterprises.

C-06 AGER RIVER. (Basis: References 6, 12)

a. The AGER River, together with its tributary, the VOECKLA, has a 1261 km^2 drainage area. It is the largest tributary of the TRAUN. The river is basically of the same geographic, geologic and hydrologic character as the TRAUN. The AGER basin contains the following major Alpine lakes:

Lake	Surface Area (Km^2)	Volume (m^3)	Elevation (m.u.A.)
FUSCHLSEE	2.66	99.5	663.59
ZELLERSEE	3.47	53.2	554.16
MONDSEE	14.20	510.	481.08
ATTERSEE	46.80	3933.6	469.25

b. Between the ZELLERSEE outlet ad the junction with the TRAUN; The AGER River is extensively developed for power production by means of old hydraulic structures. These are mostly fixed overflow weirs equipped with hand-operated sluices. Side canals from the upper pools supply water to factories, mills and municipal powerplants.

c. According to Oesterreichisher Kadaster-Ager 1950, (Reference 6), the following installations now exist in the AGER River basin:

ZELLERACHE, Km 77.27-70.25: 14 fixed weirs serving 16 small mills
SEEACHE, Km 59.20-56.50: 4 fixed weirs serving 5 factories
AGER, Km 33.71-0.00: 16 weirs serving 28 factories and 3 powerplants (municipal)

TABLE C-I

TRAUN RIVER HYDRAULIC STRUCTURES

Km 118 - Km 0

Name of Structure	Km	Stage Elevation Upper Pool, Tailwater (m.u.A.)	Length of Structure (m)	a. Type of Structure b. Navigation Locks, raft passage c. Industry Canals, Power Developments
SEEKLAUSE STEEG R-39	118.04- 117.81	508.35 508.00	102	a. Lake closing structure (Klause) b. — c. Intake into MUEHLBACH on the right
STEEG POISTER	117.99	508.00 506.20	112	a. Fixed overflow wooden Dam with 83 stoplogs b. — c. —
GOERB POISTER	115.23- 114.97	503.30 501.30	39.19	a. Fixed overflow wooden Dam b. — c. Headrace intake on left
GRANITZ POISTER	115.21- 115.04	503.30 501.30		a. As above. It is inclined with GOERB POISTER b. — c. Intake into MUEHLBACH on the right side
EISL POISTER	114.64- 114.00	500.70 498.70	136.5	a. Fixed overflow Dam b. — c. Intake in MUEHLBACH on left side
GOISERER TRAUN-WEHR	113.69- 111.50	496.70 495.20	34+45	a. Fixed wooden overflow dam, 34 m long and 0.90 m high reclining shutter b. — c. Right side intake in GOISERER MUEHLWASSER
ANZENAU POISTER	110.52- 109.62	484.90 483.10		a. Fixed overflow dam b. — c. Intake in MUEHLBACH on the right

TABLE C-I (Continued)

TRAUNSEE KLAUSE (SEEKLAUSE GMUNDEN) R-43	73.08- 72.87	422.44 421.20	167+190 357	a. TRAUNSEE closure (KLAUSE) consisting of KOSSIMUEHL-WEHR (Dam) & KUZZMUEHL-WEHR (Dam) b. 3 Navigation locks 8.75, 8.70, 8.50 m wide c. On the right, 38.6+8.5 m long weir with 2 Turbine units. On the left, intake into a millrace with 2 waterwheels
GOGLMUEHL and VOGLSANGWEHR	72.49- 72.33	420.85 418.18	85+120	a. Fixed overflow Dam, 2 parts: 85 m left and 120 m right side. The right side VOGLSANGWEHR 34 flood shutters. b. 2 navigation locks. Raft floating passage c. 2 turbine units on the left side: 18 m^3/sec capacity, 2.05 m head. The right side power installation out of commission.
THERESIENTHALER-WEIR	71.13- 70.79	418.26 416.26	275	a. Fixed overflow dam inclined across the river (418.11 m.u.A. crest). 13.25 wide flood outlet with 5 shutters b. 2 navigation locks, 7 m wide raft floating passage c. 96 m long headrace on the left 4.00 deep, 2 Francis turbines 23.55 m^3/sec. 60 m long tailrace
RADLMUEHLWEHR	66.59- 66.29	413.25 407.25	50+2x10	a. Reconstruction of the old dam. New dam 50 m long, fixed overflow weir and 2 sluice gates 10 m wide x 4.00 high each. Bottom outlet 3.0 x 5.5 m. b. — c. 3 turbine units: 26.5, 2 at 22.5 m^3/sec, 75 m^3/sec capacity.

TANZERMUEHLWEHR	64.94	407.24	27.5 +2x5.20 +2x3.70	a. 2 flood openings: 5.20 wide, 2.18 high; 2 weir openings 3.7 m wide, 4.28 m high; fixed weir 27.5 m long, crest 406.24 m.u.A. with 1.0 m high reclining shutter b. — c. 4 turbine units 52-60 m^3/sec capacity
KOHLWEHR	64.45- 63.55	400.25 396.80	22+145	a. Fixed overflow dam, oblique across the river b. 1 lock, Raft passage c. On left side 298 m long headrace 13 m^3/sec flow; 2 turbines 6.5 m^3/sec each, 3.20 m head
STEYERMUEHLWEHR	63.27- 62.29	396.40 393.10	164	a. Fixed overflow Dam b. 1 navigation lock 7.5 m wide raft passage c. 450 m long headrace; 2 Francis turbines 2x11 m^3/sec; 80 m long tailrace
GESCHROEFFWEHR	61.96- 61.83	392.70 390.74	65+70	a. As above b. 1 lock 8.55 m wide raft passage c. 53 m long headrace; 26 m^3/sec flow capacity utilized by 3 Francis turbines 8.7 m^3/sec each
SIEBENBRUNNERWEHR	59.73- 59.70	390.33 384.24	67	a. Roof weir 16.0+16.8 m +8.5 (Raft passage) Sluice gate 3.0 m (bottom outlet)+ 16.8 (intake) b. — c. Left side industry canal 16.8 m wide 50 m^3/sec flow; 3 Kaplan turbines 16.5 m^3/sec, 1000 HP each

TABLE C-I
P 3 of 4 pp

TRAUENFALLWEHR	59.50	384.14 375.30 (for weir) 382.66 366.33 (for power-plant)	155+21	a. 155 m long fixed Dam and 20.85 m reclining hinged gate, and 2 natural waterfall closures 8.35 m wide b. 1 navigation lock out of commission c. On the right, 523 m long tunnel to powerplant 30 m^3/sec; 4 Francis turbines; tailrace 80 m long
KEMATINGERWEHR	54.48- 54.17	362.63 357.43	58+139.6	a. Fixed overflow dam with flap b. Raft passage c. On the right, headrace 39 m^3/s 100 m long; 3 Francis turbines 13 m^3/sec each, 5.20 m head
LAMBACHER SPINNEREIWERKE (Textile Mill)	48.90	351.88 347.80	109	a. Fixed dam, 0.30 m high wooden removable cap b. 1 lock, raft passage c. 505 m long headrace; 4 Francis turbines total 16 m^3/sec, 990 HP
WELSER TRAUNWEHR	36.20	326.00 318.81	3x29.5	a. A fixed dam, crest elevation 324.54 m.u.A., topped by 3 reclining hinged shutters, 1.46 m high. Flood gates, bottom outlets. b. — c. On the right, 2069 m long canal, leading to powerplant, 48.5 m^3/sec capacity. 2 Kaplan turbines, 14.5 m^3/sec each; 12 m head. 2 Francis turbines, 14.5-13.5, 8 m head; 1 turbine 5.5 m^3/sec 8 m head. Tailwater 313 m.u.A. Tailrace 130 m long. On the left side, intake in MUHLBACH, 7 m^3/sec capacity.

EXHIBIT D

HYDRAULIC DEVELOPMENTS IN THE ENNS RIVER BASIN

PAGE

TABLE

EXHIBIT D

HYDRAULIC DEVELOPMENTS IN THE ENNS RIVER BASIN

D-01 INTRODUCTION.

This exhibit consists of abstracts of technical literature concerning the physical and hydraulic characteristics and the hydraulic developments of the ENNS River Basin of the AUSTRIAN ALPS. Reference is made to paragraph A-01 of Exhibit A for discussion of the source material and other reference data.

D-02 TOPOGRAPHY. (Basis: References 6 & 12)

a. The ENNS River is a 254 km long tributary of the DANUBE. It drains 6090.7 km^2 of Austrian territory and originates on the north slopes of the LOWER TAUERN southwest of RADSTADT.

b. For 20 km, to OBERNDORF, the ENNS valley follows a south-north direction then turns sharply eastward. This west-east longitudinal valley continues for 102 km to the entrance into the GESAEUSE Gorge at Km 134. From there, it follows the 15.5 km long, narrow and very deep gorge known as "GESAEUSE SCHLUCHT." This gorge is blocked in many places by huge boulders. Below HIEFLAU, the ENNS then turns sharply towards the north, continuing to be confined to a rather narrow deep valley for 71.4 km. Beginning at TERNBERG, Km 48, it flows through the Flysh Zone to STEYR (Km 32), followed by the Alpine Foreland Zone to MAUTHAUSEN on the DANUBE. The ENNS joins the DANUBE at Km 2112. (Kilometrage set by the International Danubian Commission, and measured from GALATZ on the BLACK SEA)

c. The ENNS has 21 tributaries on the right side, the largest of which is the 90 km long SALZA which has 867 km^2 drainage area. There are 13 tributaries on the left side, the largest being the STEYR (63 km long and 916 km^2 drainage area). Another left bank tributary is the MITTERNDORFER SALZA, a 24 km long stream draining 243 km^2. The SALZAWERK is located on that stream. The valleys of the left side tributaries are usually short because the watersheds are close to the river. Many longer valleys lead to the right bank.

D-03 GEOLOGY (Basis: References 6 & 12)

a. The upper part of the ENNS valley is of calcareous and quartz phyllitic background, Serizit schist also appears in places. Below WLACHAU, the wide valley floor is covered with alluvial sediments.

d-03

b. The longitudinal west to east part of the ENNS is a distinct tectonic furrow, cutting sharply into the neighboring mountainous groups along the east and northeast failure line that forms the boundary between the limestone NORTH ALPS, the crystalline CENTRAL ALPS, and the grey wacke zone. Tertiary sediments extend along the course on its edges. At ADMONT, the ENNS valley crosses the boundary between the Limestone ALPS and the grey wacke zone. (See Plate 4 of this report).

c. In the GESAEUSE GORGE, the ENNS valley breaks through several calcareous and dolomitic zones such as the Dachstein Limestone and Ramsau Dolomite. Everywhere in this part of the ENNS valley can be seen evidence of the past glacial epochs. The end moraines of the previous ENNS glacier are well preserved in BUCHAUER PASS, in KAISERAU PASS, south of ADMONT, and also at GROSSRAMING, LANDL, and ST. GALLEN.

d. Even after turning north at HIEFLAU, the course of the ENNS continues to break through layers of the NORTH LIMESTONE ALPS, ranging from Triassic to Upper Jurassic. At TERNBERG (Km 48), the NORTH LIMESTONE ALPS ends and the ENNS enters the Flysch Zone in which it remains up to STEYR. Here, begins the Alpine Foreland of Ernsthofen diluvial sediments forming terraces covering the Schlier background. The diluvial terraces extend farther downstream and contain mostly quartz and crystalline or calcareous rubbles, covered by loess.

D-04 HYDROLOGY. (Basis: References 6 & 12)

a. The ENNS is an Alpine stream depending on precipitation in the high mountains but not by melting of glaciers. Heaviest rainfalls occur during July and August. Lightest rainfall occurs in November in the upper and middle ENNS valley and in February in the lower ENNS valley. The heaviest precipitation appears around SCHLADMING, the lowest in the area near the ENNS-DANUBE junction.

b. Characteristic discharges of the ENNS River, based on long range averages, may be indicated by examination of data given for the gaging stations, WENG (Km 135) and STEYR (Km 32).

c. At WENG, the end of the longitudinal west-east course, the maximum discharge of 143 m^3/sec occurs in May. This corresponds to 53 liters/sec/km^2. The annual mean discharge (MQ) is 69.4 m^3/sec according to Reference 12.

d. At STEYR the corresponding figures for May are 337 m^3/sec (without the STEYR River) and 445 m^3/sec (including the STEYR). The corresponding minimums in the January-February period are 103 and 128 m^3/sec, respectively. The annual MQ are 177 and 225 m^3/sec, respectively. The Austrian Wasserkadaster 1950-Enns (Reference 6), gives for the

annual MQ at STEYR the following data:

40 year period, 1909-48 183 m^3/sec
54 year period, 1896-49 179 m^3/sec

This corresponds to 35.84 liters/sec/km^2. The maximum discharge in this period was in 1944 and amounted to 240.33 m^3/sec (MQ plus 34.2%). The minimum discharge of 118.8 m^3/sec (MQ minus 33.7%) in 1898. The absolute maximum (HHQ) was 2900 m^3/sec and NNQ 34 m^3/sec according to Reference 6.

D-05 ENNS RIVER BASIN. KM 254 TO KM 222
(Basis: References 6, 12, 28, 69)

This part of the ENNS River, in the Province of SALZBURG, was developed in the period going back for several centuries. Power developments are primitive, being mostly water wheels for production of mechanical power. Small milling machines are coupled directly on the water wheels. Only exceptionally is the flow converted into hydroelectric power. Usually a fixed wooden weir (in a few cases equipped with movable parts) impounds the flow and diverts it into industrial canals, on which are located several industrial enterprises that individually utilize the flow by means of mechanical water wheels. The 1950 ENNS section of Reference 6 lists 14 industrial canals. The largest (between Km 235 and 230) is the LOHBACH-ALTENMARKT Canal, a 547 km long canal serving small industrial enterprises. The maximum utilized flow of this canal is 2 m^3/sec.

D-06 ENNS RIVER BASIN. KM 222 TO KM 93
(Basis: References 6, 12)

a. General.

(1) The channel of this 130 km long reach of the ENNS River, in the Province of STEIERMARK, is regulated by extensive curve rectifications, bank revetments, quays and other means of bank protection, particularly where the railroad lines or highways run close to the river. These ENNS regulating works are continuous between MANDLING (Km 205) and the GESAEUSE Gorge entrance (Km 135).

(2) For purpose of hydroelectric power development, several projects have been under consideration since 1922, particularly in regard to the so-called "GESAEUSE" part of the ENNS River between Km 134 and Km 118. This reach consists of a very deep gorge, blocked by huge boulders. The first part of this GESAEUSE gorge is 3 km long and has a 30 m fall; the second part, between KUMERBRUECKE and HIEFLAU, is 8 km long and has a 85 m fall. From there on, the ENNS River, after being joined by the SALZA River on the right, makes a sharp turn northward, dropping another 80 m in that 25 km long course.

This part of the ENNS River, from ADMONT (Km 141) to ALTENMARKT (Km 93), is especially suitable for power development. The HIEFLAU development is under construction in this reach. As a part of this power development, the SALZA-KRAFTWERK on the MITTERNDORFER SALZA was constructed. This is the first step in developing a series of storage reservoirs in this part of the ENNS River.

b. SALZA Development (Plant No. E-46).
(Basis, References 6, 12, 28, 69, 73)

(1) This development is located on the MITTERNDORFER SALZA, tributary of the ENNS at Km 181.9. The main part of the development is a concrete arch dam, bridging the narrow SALZA valley (known as STEIN PASS), 2 km above the mouth of the SALZA, near ST. MARTIN. The project was planned since 1920. However, actual construction was carried out in the period from 1947-49. The dam is a symmetrical circular arch. (A sketch of the structure appears on Plate 9a). The dam is known also as GRIMMING Dam. Its main dimensions are as follows:

Maximum pool elevation	771.00	m.u.A.
Minimum pool elevation	745.00	m.u.A.
Stilling basin elevation	731.00	m.u.A.
Storage capacity	10.5	hm^3
Lake area	26	ha (80 re another
Total height of dam	53.0	m
Dam height above valley floor	50.0	m
Crest length	120.0	m
Crest width	4.0	m

(2) The drainage area of the SALZA River at the dam is 150 km^2, corresponding to 145 hm^3 annual discharge. The max high water flow amounts to 140 m^3/sec, which is carried over the crest. The utilized flow for power production is 8.6 m^3/sec.

(3) The diversion tunnel, used during the construction, is located on the right bank of the reservoir lake. It is 160 m long, 1.08 m inside diameter and its flow capacity is 11 m^3/sec. The entrance to the emergency diversion tunnel is equipped with a trash rack with 0.1 m spacing between bars, a throttle valve of 1.0 m inside diameter, and a cylindrical valve. This tunnel empties directly into the stilling basin.

(4) The intake structure for the pressure tunnel is developed on the left side of the reservoir lake. It is equipped with a fine trash rack at the inlet and 2 throttle valves, each 1.95 m inside diameter. One is hand operated, the second operated by remote control, with automatic control in case of pipe break. The pressure tunnel is 320 m long and has an inside diameter of 2.4 m. It empties into a 478 m long penstock consisting of a steel pipe of 1.8 m inside diameter. The pipe crosses the SALZA River on 2 supports with a 23.5 m span and crosses RUNSEN CREEK on a bridge of 36 m span.

...e			...zed ...Flow m³/sec	Head m	Power Capacity KW
...NSTEIN	55.70	...6.0	240	15.5	30,000
...U	40.20	...0	240	12.5	25,000
...TALEON	00.00	...10	220	19	34,000

...) The propos... features of the four weirs and ... in the ... stage are summarized in the following

...its in Planning Stage

...r ...	Upper Pool Elevation	Utilized Flow m³/sec	Utilized Head m	Power Capacity KW
...0	397.0	240	11	21,000
...53	385.5	240	11	21,000
...5	301.00	160	6	7,500
...00	294.50	160	6	7,500

...Weir and Powerplant (Serial No. R-47)

...velopment was constructed in the period 1942-50. ..."run-of-the-river" powerplant, consisting of a ...penings, each 22.5 m wide. The outstanding ...opment is the location of the power units on ..., close to the banks. Another important ...gement of weir openings. These consist of upper/# ... a fixed part of the weir structure. At ...r part of the opening is 5.5 m high, and equipped ... hinged shutter. The bottom opening is divided into ... m wide and 5.1 m high, and equipped with lifting ... fixed middle part of the weir is 14.4 m high. The ...ght of the weir and gates is 25 m. The 2 upper ...rough-flow capacity of 1000 m³/sec. The total ...ity of the weir, when all gates are open, is ...00 according to another source). A sketch of the ... on Plate 9e of this Report.

(2) The upper pool, at elevation 371.0 m.u.A., extends for 12.6 km upstream to Km ... 00, and has 200 m maximum width, 25 m maximum depth and 122 ha surface area. The total storage capacity is 16 hm^3, of which 1.22 hm^3 is utilized for power production at 1.0 m lowering of the stage from 371.0 to 370.0 m.u.A.

(3) The powerplant consists of 2 Kaplan turbine units coupled directly with vertical synchronous generators. The turbines each have 130 m^3/sec flow and ...,000 KW power capacity at 23.8 m head.

c. TERNBERG Weir and Powerplant (Serial No. R-48)

(1) This plant was constructed in the period 1942-49. It is located at Km ...900 in a ... of the river, forming a river bay on the left side which was used for placement of power units.

(2) The movable weir has 3 openings, each 16 m wide, and consisting of a movable upper part and of a bottom outlet, separated by the fixed part of the weir structure. The upper openings are 7 m high and are equipped with ... gates with a horizontally hinged shutter on top. The flow capacity of the shutter opening is 300 m^3/sec. The middle fixed part is 6.0 m high, the lower opening of the weir 4.5 m high. The total height of the structure is 17.5 m. (See Plate 9e of the report for sketch of the weir). The flow capacity of the weir, at full opening of all gates, is 3700 m^3/sec (or 4000 according to other sources).

(3) The upper pool, elevation 330.0 m.u.A., extends 7.8 km upstream to Km 55.70. The total storage capacity is 5.1 hm^3. The utilized volume for power production in the upper 1.5 m of the pool above 328.5 m.u.A., is 0.8 hm^3.

(4) The TERNBERG powerplant consists of 2 Kaplan turbine units, each of which has 120 m^3/sec flow capacity and 15,000 KW power capacity at 15.5 m mean utilized hydraulic head. The generators are coupled directly on the vertical shaft of the turbines. Because of the topographic location, both turbine units are placed in the river bay on the left side in an extension of the weir structure.

d. STANING Weir and Powerplant (Serial No. R-51)

(1) This project was constructed in the period 1941-51, with an interruption from 1945 to 1946 because of the war. Located at Km 20.0, the development is constructed as a "run-of-the-river" powerplant. The power units are located on the right end of the weir structure.

(2) The movable weir has 5 openings, each 17 m wide, and is arranged similarly to those at GROSSRAMING and TERNBERG. It consists of upper and lower parts, equipped with gates, and a fixed middle part.

The upper openings, 4.0 m high, are equipped with lifting sluice gates, which may be used at the same time as emergency closure for the bottom openings of the weir. The regular closure of the bottom openings is by means of a segment shutter 2.8 m high, 17 m wide. The fixed middle part of the weir is 6.0 m high. The total height of the weir is 12.8 m. The flow capacity of the upper openings is 1250 m^3/sec and, at full openings of all gates, the weir can release 3350 m^3/sec (or 3500 according to other sources). A sketch of the weir is shown on Plate 9e.

(3) The upper pool elevation of 282.0 m.u.A. extends 9.72 km upstream to Km 29.72. The total storage capacity of the upper pool is 10 hm^3. The upper 1.0 m above elevation 329.0 m.u.A. provides 2.0 hm^3 utilized storage for power production.

(4) The powerplant, located at the right end of the weir structure, consists of three Kaplan turbine units, each 100 m^3/sec flow capacity and 11,000 KW power capacity at 13.5 m utilized hydraulic head. The turbines have vertical shafts and are directly coupled to generators.

e. MUEHLRADING Weir and Powerplant (Serial No. R-32)

(1) This hydroelectric structure constructed in the period 1941-52, with a wartime interruption during 1945 is located at Km 13.80. Developed as a "run-of-the-river" powerplant, it consists of a movable weir and a powerplant. The latter is located on the left side in an extension of the weir structure. The total length of the structure is 170 m.

(2) The weir has 5 openings, each 17.25 m wide and 9 m high. The openings are closed by means of double sluice hook gates. The upper leaf is 3 m and the lower leaf 6 m high. The flow capacity of the upper leaf openings at 3 m head is 1250 m^3/sec. The total throughflow capacity of the weir at full opening of both leaves is 3300 m^3/sec.

(3) The upper pool elevation, 268.0 m.u.A., extends 6.2 km upstream to Km 20.0. The pool has a 5.0 hm^3 storage capacity of which 1.0 hm^3 in the upper 1.0 m above elevation 267.0 m.u.A. may be utilized for power production.

(4) The powerplant at MUEHLRADING has 4 turbine units, each 75 m^3/sec flow and 6100 KW power capacity. The hydraulic head varies between 5.55 m minimum to 9.53 m maximum, the mean head being 9.0 m. Similar to other powerplants on the ENNS, the turbines have vertical shafts and are coupled directly on the generators.

TABLE D-1

ENNS RIVER, KM 9[illegible]-0

EXISTING WEIRS AND POWERPLANTS

Name & Serial No.	River Km	Drainage Area (Km^2)	a. Upper Pool Elevation (mmA) b. Length (km) c. Total Volume (hm^3) d. Utilized Volume (hm^3)	Tailwater Elevation (mmA) a. NNW b. MNW c. [illegible] d. MHW e. HHW	Discharge (m^3/sec) a. NNQ b. [illegible] c. MQ d. MHQ e. HHQ
GROSSRAMING R-47	64.400	4,644	a. 371.00 b. 12.6 c. 16.0 d. 1.22 (1.0 m)	a. 345.50 b. - c. 346.55 d. - e. 354.30	a. 34 b. 40 c. 141 d. 1060 e. 2900
TERNBERG R-48	47.900	4,903	a. 330.00 b. 7.800 c. 5.1 d. 0.8 (1.5 m)	a. 3[illegible].75 b. - c. [illegible] d. 318.15 e. 323.00	a. 55 b. 55 c. 141 d. 1120 e. 2900
STANING R-51	20,000	6,004	a. 289.00 b. 9.72 c. 10.00 d. 2.00 (1 m)	a. 267.60 b. - c. 269.40 d. - e. 275.50	a. 36 b. 76 c. 182 d. 1400 e. 3300
MUEHLRADING R-52	13.800	6,070	a. 268.00 b. 6.20 c. 5.00 d. 1.00 (1 m)	a. 258.10 b. [illegible] c. 260.45 d. - e. 265.7	a. 36 b. 76 c. 178 d. 1400 e. 3300

NOTES: 1. See Par. A-07b to A-07e for additional description
2. Source: Reference No. 28

[illegible]	No.	Width (m)	Height (m)	Flow (m^3/sec)	Kaplan Turbine Units No.	Mean Head	Maximum Utilized Flow m^3/sec	Max. Power Cap. KW	Remarks
	a. Movable Upper Openings b. Fixed Middle Part c. Movable Lower Openings d. Total								
34	a. 2	22.5	5.5	1000	2	[illegible].80	260	54,000	Upper gate: revolving flap, horizontally hinged. Lower gate: lifting sluices
40	b. -	-	14.4	-					
143	c. 4	9.0	5.1	-					
360	d. -	-	45.0	3500 (or 3700)					
000									
[illegible]	a. 3	16.0	7.0	300*	2	15.50	260	20,000	* Only for the flap of the upper leaf
53	b. -	-	6.0	-					
[illegible]	c. 3	16.0	4.[illegible]	-					
[illegible]	d. -	-	17.5	3700 (or 4000)					
00									
35	a. 5	17.0	4.0	1250	3	12.50	300	16,000	Upper gate has horizontally hinged flap
75	b. -	-	6.0	-					
182	c. 5	12.0	2.8	-					
000	d. -	-	12.8	3350 (or 3500)					
[illegible]									
35	a. 5	17.25	3.0	1250	4	8.35	300	16,000	Double leaf sluice gates
75	b. No fixed middle part								
175	c. 5	17.25	6.0	-					
[illegible]	d. -	-	9.0	3500					
000									

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TABLE D-1
RHINE RIVER, Km. 93-0—Existing Weirs